SCHOOL SCIENCE AND MATHEMATICS

VOL. XV, NO. 5 MAY, 1915 WHOLE NO. 124

HOW MAKE LABORATORY WORK IN PHYSIOGRAPHY CONCRETE.

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How make laboratory work concrete sounds indeed very like a paradox; for if laboratory work is not concrete, how can it be called laboratory work? It is true that the actual subject matter of physiography cannot be handled as can that of physics or botany, but I believe the work is concrete and that it can be made increasingly so. In planning laboratory work, we must avoid what has been called "busy work," and "the elucidation of the obvious." Real laboratory work will make the pupil feel that the facts learned are indeed his "by direct experience," which I understand is the meaning of the word concrete. I believe that physiography can be made to touch life as the ninth grade pupil knows it more closely than other subjects, but it must be made simple and as free as possible from technicalities.

The material used in the laboratory should be, as far as can be everyday appliances. Many illustrations should be drawn from the pupil's experience and the experience of his friends. The meaning of each exercise and its bearing on the general plan of the work should be brought out and emphasized, so that the pupil will not ask himself in bewilderment—Who cares?—What of it, anyway?—or think that the main object accomplished is the adding of one more page in his notebook to help him towards a credit. Laboratory work must be such as to strengthen the attitude of mind which makes a person hesitate to accept what he has not arrived at himself; what he can not verify for himself, and what does not appeal to him as reasonable.

We have one-half year for physiography in Chicago. I prefer to have no stated days for laboratory work, and to do such work, or textbook work, as occasion demands, spending sometimes five days a week, sometimes one day a week, on what may be called laboratory work. At present I begin with a study of the atmos-

phere and find that an exercise on the expansion due to heat is a most acceptable one for a beginning. It is easy for the pupil to make the matter of this exercise his by actual experience; for besides the ball and ring used in class, most pupils can give from life as they know it, examples of expansion of solids due to heat. Expansion in liquids leads us to the thermometer, the changing density of water, and the breaking of pipes by freezing water. Every pupil has enjoyed plugging tightly a cold bottle and throwing it into a fire, and he is pleased to recognize the result as due to the effect of heat on gases.

Exercises on the distribution of heat on the earth, and the influence of latitude and land and sea on temperature, necessitate the study of maps and isotherms. We can not actually journey far abroad and experience the temperature changes for ourselves. We can journey in imagination, and make the conditions noted our own by descriptions and pictures, and by comparison with the conditions with which we are familiar. Constructing a barometer with the class is not enough to make its use and application real. If this is followed by reading the barometer daily and discussing briefly the changes as they occur, the barometer becomes an actual thing.

The wind belts can be developed on a blackboard globe if the school possesses one of large size. Plotting the belts on a world map, while not giving a first hand acquaintance with the winds themselves, fixes them in the mind, and makes a definite impression such as mere textbook study can never do. The ninth grade pupil is a very young thing and the formal feelings still appeal to him strongly. He is inclined to regard the drawing of the lines of a diagram as the real exercise, instead of looking for the interpretation of the drawing. This has been to me a real difficulty, and unless definite time is given to emphasizing why we have done the work, and what the diagram means, the pupils are inclined to regard, the drawing of the lines as the desideratum.

As we study the weather map the members of the class compare recorded conditions with those we experienced ourselves the day before. (Our map reaches us at the end of the day when school is over.) The boys and girls often stop before and after school, and between classes, to call each other's attention to the record of conditions which impressed them and to what they think the weather will probably be for the next few days.

At the beginning of the study of the land, individual small globes seem almost a necessity; for parallels, meridians, latitude,

longitude are terms too often badly mixed. Indeed they are still confused after many exercises.

A brief and, what seems to me, most meagre study of a few of the common minerals and rocks, pleases the pupils and serves as an acceptable introduction to the study of weathering. The pupils realize that minerals are not equally resistant, and that rocks do not yield with the same rapidity to the forces which attack them. The pupils look about them with an increased intelligence and bring in all sorts of things from the lake shore, from excavations being made for buildings, from the quarry, from the most unexpected places. As we begin this work, I realize again the lack of appreciation on the part of the pupil, that what he is reading about and what he sees around him are the same things. He comes to us thinking, somehow, that the discussion in the book must of necessity apply to places remote. It takes a direct effort on the part of the teacher to get most pupils in the habit of connecting what they read with what they see. They read that mantle rock is "loose material such as sand, gravel, clay on the surface of the ground." The majority of a class of forty will say that glibly enough, and then all of them, boys and girls, will declare that they never saw any mantle rock. So with bed rock, until some one suggests that perhaps the rock in an old quarry a mile or so from the school, may be bed rock. Unless the teacher takes special pains to connect what is around them with what is being talked about, the pupils do not make the connection, and the work never becomes concrete.

I have difficulty with the question—what rivers join Lake Michigan at Chicago? The children are surprised and pleased to find that the river on the map is the same one they cross on the Ninety-second street bridge.

When we take up the study of rivers, it has proved profitable to do considerable place geography, locating repeatedly the rivers, cities, states we speak of, and learning the names of the states so that a fair proportion of the class can name the states on an outline map of U. S. The work on rivers, glaciers, mountains, shore lines is less abstract when the class has a reasonably correct notion of where the important features are located.

In the study of land forms, I think topographic maps are most helpful, not detailed study of one or two maps but rapid study of the main features of as many maps as possible, comparing one with another. More than one aid to the understanding of the meaning of a topographic map is useful. (1) As an introduction

to the contour maps an exercise with a sand island is helpful. Draw rapidly a line to show the outline of the sea shore, with successive lines to represent the shore lines as the water is imagined to rise. (2) A piece of apparatus purchased some time ago serves this purpose well. It is of wood and represents a hill. The hill is made in horizontal sections and the cracks between the sections represent contour lines. Another part of the apparatus shows these contour lines as continuous pieces of metal on upright wires, forming a skeleton of the hill. The uprights on which the metal contours rest, can be pushed through the base bringing the contours to one plain and forming a contour map of the hill. (3) We have a set of small plaster models of a portion of the La Salle street. When these are studied with the map they bring out its meaning admirably. (4) From time to time pupils have made pasteboard models of various maps studied, and these are an excellent help in seeing a map as sort of a bird's eye view of the region. It has seemed to me that these various devices have made it possible for a class to read the main features of a topographic map, with a fair amount of ease. I hope I have not been deceiving myself.

After maps can be read, they make an excellent basis for the study of river work, the effect of the glacial invasion, shore lines. For ninth grade pupils such study should be made calling the attention to the main, big features illustrated, and with as many maps for comparison as the resources of the school equipment will allow. It is unfortunate that a class cannot be supplied with copies of Professional Paper Number 60 of the U. S. Geological Survey—"The Interpretation of Topographic Maps," by Salisbury and Atwood.

In the study of stream action and shore lines, a sand table makes clear many points which are hard for pupils to understand who have lived in the shadow of the steel mills most of their lives. On the sand table they see the difference between the river valley and the channel; flood plains and river terraces are being made, and the widening of valleys by lateral cutting is rapidly taking place before them. I find it an advantage to be in a part of the city where in places paving is still a thing of the future, and where rainwash makes gullies and alluvial fans on the side of the street.

I have avoided mentioning field trips as the discussion of these is another part of the program. Laboratory work calls constantly for illustrations from near-by places, which is most

valuable even when supplied by only a few members of the class. Lantern slides illustrate and emphasize the points made. With a little encouragement the children will find pictures from Railroad advertisements and other papers and will bring them in as illustrations of forms and processes discussed.

In general, I make use of various forms of apparatus, of diagrams, of sand and pasteboard models, of pictures, of constant and repeated reference to what we are seeing about us. If the subject is not obscured by scientific jargon, pedantic and absurd, physiography, or as I prefer to call it, High School Geography, is indeed concrete and a delight to the average child. I wish that my pupils might go from my classes feeling that "whereas they were blind, now they see."

EYESTRAIN IN CHILDREN AFTER THE MEASLES, SCARLET FEVER AND ALLIED DISEASES.

Our excellent boards of health in many cities in the Union, have very wisely directed that children suffering from the diseases above mentioned should be segregated from the rest of their companions in school for a considerable length of time during the continuation of their affection as well as afterward for fear of infection or possible contagion. This is eminently proper, and should be persisted in carefully, and a rigid quarantine effected and properly maintained during the disease and so long afterward as is deemed necessary.

There is, however, an additional reason why after an apparent cure of the local or constitutional disease, the children so affected should be granted a considerable vacation, and that is the eyestrain which almost invariably accompanies these diseases, and continues with the sufferer for some time after apparent bodily recovery. If we permit children so affected to enter school at once, at the time when the physicians permit them to return as free from contagion, there is great probability that bad results will follow, so far as the eyes are concerned. For they are at this time weakened for use at near objects, and the sudden exertion demanded from them, as for instance, in writing in a book and then looking at a distant blackboard for notes, or in looking at a book and then at an example on the blackboard exerts the accommodation of the eyes to an unusual degree and leads to eyestrain from which recovery may not take place for months. Instances of this sort have also been recently observed after the mumps, in which the eyes could not be used for near work for seven weeks, the least exertion being followed with a flow of tears, smarting and burning of the eyes.

Instances of this sort of eyestrain, occurring daily in the practice of oculists, prove how intimately the eyes are connected with the body and the folly of regarding them as mere things by themselves, the sight of which needs only to be tested by inexperienced men. People have to be taught by constant repetition, that the eyes are a part of the body, and are constantly exhibiting symptoms, such as have above been mentioned, to prove their close relationship.—*Journal Am. Med. Assoc.*

THE USE OF ALGEBRA IN WRITING CHEMICAL EQUATIONS.

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A chemical equation may be regarded as a representation by means of special symbols of the material transformations that take place in a chemical reaction. We have the facts of the reaction established by experiment and measurement of weight or volume, the numbers called atomic weights, and the formulas of the compounds determined by analysis.

Our procedure then is (1) to form a tentative equation writing the formulas of the factors on the left and those of the products on the right and (2) to make the equation "balance" by writing in the proper coefficients.

How do we determine these coefficients? Various methods are in use as "by inspection," by the principles of valence, by the principles of the theory of electrolytic dissociation, successive reactions, or by mere memory. Perhaps many prefer to remember that in the reaction between copper and dilute nitric acid yielding nitric oxide as one of the products, the coefficient of the copper and nitric acid are, respectively, 3 and 8, or in the reaction in which potassium permanganate acts as an oxidizing agent in acid solution, two molecular weights of potassium permanganate yield five atomic weights of oxygen for oxidizing purposes.

There are cases, however, where the determination of the coefficient by any of the foregoing methods presents considerable difficulty. The problem is fundamentally algebraic. Why not then try the application of algebra for its solution? Leaving aside all considerations other than weight relations, the problem may be put thus: By what numbers shall the molecular weights be multiplied, so that the products so obtained shall stand in the ratio of the weights of the substances taking part in the reaction?

Let us suppose we have shown by experiment that kaolinite heated with concentrated sulphuric acid yields aluminun sulphate, metasilicic acid and water, and wish to represent the fact by an equation. We write:

$$x\ H_4Al_2Si_2O_9 + y\ H_2SO_4 = z\ Al_2(SO_4)_3 + w\ H_2SiO_3 + t\ H_2O$$

Now since the equations must balance, the hydrogen on one side, $4x+2y$ must equal the hydrogen on the other, $2w+2t$

or, $4x+2y = 2w+2t$

(1) or $2x+y = w+t$

The same is true for the aluminum, hence

$$2x = 2z$$

(2) $x = z$

Likewise for the other elements,

(3) $2x = w$

(4) $9x + 4y = 12z + 3w + t$

(5) $y = 3z$

Since the same value of x must satisfy all the relations the equations are simultaneous. Let us find an expression for the value of each unknown quantity in terms of some one chosen unknown quantity. We choose z

(6) In (2) $x = z$

(7) In (5) $y = 3z$

(8) From (3) and (6) $w = 2z$

From (1), (6), (7) and (8) $t = 3z$

Assigning for the value of z the smallest number that will make the values of the other unknown quantities integers, (the form is frequently fractional) namely, we have $x = 1$, $y = 3$, $z = 1$, $w = 2$, and $t = 3$, which values written as coefficients in the equation, it will be found to balance.

We did not make use of the equation (4) because we were able to obtain an expression of the value of each unknown quantity in terms of z without it. We are seeking to establish only relative values, for any multiples of the values found would make the chemical equation balance. The values found will, however, satisfy equation (4) also.

A few more examples are given to show the working of the method. Sulphuric acid and potassium mangnate yield potassium permanganate, potassium sulphate, manganous acid and water.

$$x\,H_2SO_4 + y\,K_2MnO_4 = z\,KMnO_4 + wK_2SO_4 + t\,H_2MnO_3 + s\,H_2O$$

$$2x = 2t + 2s$$

$$x = t + s$$

$$x = w$$

$$4x + 4y = 4z + 4w + 3t + s$$

$$2y = z + 2w$$

$$y = z + t$$

$$\begin{array}{r} 4y = 4z + 3t + s \\ 4y = 4z + 4t \\ \hline o = t - s \end{array}$$

$$s = t$$

$$x = 2t$$

$$w = 2t$$

$$z+2t=4t$$
$$z=2t$$
$$y=z+t=3t$$

Let $t=1$, then $x=2$, $y=3$, $z=2$, $w=2$, $t=1$ and $s=1$.

Copper and nitric acid yield copper nitrate, nitric oxide and water.

$$x\,Cu+y\,HNO_3=z\,Cu(NO_3)_2+w\,NO+t\,H_2O$$

$$x=z$$
$$y=2t$$
$$y=2z+w$$
$$3y=6z+w+t$$
$$3y=6z+3w$$
$$o=t-2w$$
$$2w=t$$
$$w=\frac{t}{2}$$

$$2t=2z+\frac{t}{2}$$
$$2z=2t-\frac{t}{2}$$
$$z=\frac{3t}{4}$$
$$x=\frac{3t}{4}$$
$$y=2t$$

Let $t=4$, then $x=3$, $y=8$, $z=3$ and $w=2$.

The student of elementary chemistry is generally at the time well trained in algebraic manipulation and will readily handle the method. Lest he is led to put too much dependence on the mere balancing of an equation, his attention may be called to the fact that balancing is not a criterion of its chemical correctness, and illustrations such as:

$Pt+H_2SO_4=Pt\,SO_4+H_2$ or

$4HCl+SiO_2=SiCl_4+2H_2O$ may be given.

The method may be outlined as follows: From the statement of the reaction write a tentative chemical equation using the symbols x, y, z, etc. in the place of coefficients. Form algebraic equations, involving these quantities, one equation for each element. Regarding these equations simultaneous, find an expression for the value of each unknown quantity in terms of one chosen unknown quantity. Assign a value to the chosen unknown quantity, which will render the values of the other unknown quantities integral. The intergers so obtained will be suitable for coefficients in the chemical equation.

SOME COMPARISONS OF VARIOUS BRANDS OF SOAPS.

By Willis H. Clark,
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Within the past year I heard in a university class in organic chemistry the statement that the cleansing action of soap depended upon the alkali formed by hydrolysis of the soap. This statement was made without qualification. Since then I have noticed in a few books treating the subject, what seemed to me over-emphasis of the rôle played by the alkali in the cleansing. To my notion the treatment in Alexander Smith's *Elementary Chemistry* is one of the most satisfactory explanations I have seen.

Besides the arguments given by Professor Smith against the ability of the alkalies formed from the hydrolysis of soap to act as cleansing agents, I would suggest a simple experiment which can easily be tried in the home. Place some greasy dishes in a pan of water. Add household ammonia until the water is ammoniacal (washing soda might also be used, being added until water is distinctly alkaline, this being tested by the "soapy" feeling), then try to wash the dishes. After washing a few, hold a bar of soap under the water and shake it back and forth until permanent suds are formed. Now wash a few more dishes. The greater ease with which the grease is removed will readily become apparent. This large increase in the efficiency of the "dish-water" is certainly not due to any great increase in the alkalinity.

However, the alkalinity of soap solutions, disregarding the effect upon the power of cleansing, is not without importance. If five brands of soap be procured, a concentrated solution of each of these in distilled water at room temperature be made, and this solution titrated against decinormal acid, methyl red or methyl orange being used as indicator, the results will make very interesting discussion in a class of students who have become familiar with the action of alkalies upon the skin, the hair, and various fabrics.

In carrying out the experiments the students were required to make a sufficient number of titrations to get results that checked fairly well. In each trial 30-35 c. c. of the soap solution were run out of the burette. The reason for taking this volume instead of 5-10 c. c. was discussed, with considerable profit. It has been my experience that students left to themselves are apt to use small volumes in titration (perhaps to save refilling their burettes) overlooking the fact that the per cent of error is increased considerably by so doing.

After the data were obtained in all my sections, the number of cubic centimeters of soap solution required to neutralize 100 c. c. of the acid was calculated by each student on the basis of his data. The data were tabulated on the blackboard. Nearly all the numbers from the same soap fell very close together; but now and then there was a result that varied considerably from the rest. The meaning of this was brought out in the class discussion. Using 35 c. c. of the soap solution it was found that from 15 c. c. to 80 c. c. of acid were required, depending upon the brand of soap.

In the discussion the following points were covered:

(1) Which soap is the best toilet soap? Is there any reason for this? What?

(2) Which soap would you choose for washing delicate woolen goods? Why? Silk gloves, etc.? Why? The hair? Why?

(3) Why should soap be carefully rinsed out of fabrics after washing?

(4) What is the effect of boiling woolen goods in a fairly concentrated solution of that soap which shows the highest degree of alkalinity? (The experiment is tried, the woolen material can easily be picked apart after drying.)

(5) What seems to be the common property of cheap soaps? (They react more than twice as alkaline as some of the soaps commonly considered best.) This might be due to the presence of what?

(6) What seems to be a property of those soaps the wrappers of which possess a premium getting value? (Incidentally, the parasitic nature of trading stamp institutions in general was pointed out.)

Simply titrating a soap solution with an acid solution does not, I am aware, give the amount of the free alkali in the soap. Assuming, however, that all of the inorganic acid used in the titration in the case of the solution of the soap of the highest grade, goes toward forming the little dissociated organic acid and the sodium salt of the inorganic acid, and assuming further that the same amount of the inorganic acid is used up for the same purpose in the case of the cheap soaps, there will still be sufficient acid used to neutralize the alkali to warrant us in assuming the alkalinity of the solutions of the cheap soaps to be in the neighborhood of one-fifth normal, and in some cases even more.

As an additional experiment, I would suggest the following as

a rough measure, perhaps, of the efficiency of soap. Samples of various brands of soap are held under water by a kitchen "soap shaker" and moved rapidly back and forth until permanent suds are produced. The soap is then removed and a weighed portion of the solution is evaporated in a weighed evaporating dish on the water bath, and finally on a hot-plate at about 110 degrees. The amount of soap actually consumed in making the permanent suds is thus obtained. The results are tabulated in four columns: Brand and price; weight of one bar; number of cubic centimeters of water in which one bar will produce permanent suds; number of cubic centimeters of water in which twenty-five cents worth will produce permanent suds.

The theoretical basis for the comparison made in this experiment is the assumption that soap solutions of such a concentration that permanent suds can just be produced have surface tensions that are low and of approximately the same value, and, further, that the emulsifying powers of the solutions are therefore approximately the same. Experiments on the surface tensions of the soap solutions used show the values of this magnitude to be about the same for each soap solution.

The practical basis for this sort of a comparison is that soap solutions of such a concentration as that mentioned represents the concentration aimed at in ordinary cleansing operations.

INDUSTRIAL DEPARTMENT OF BOISE HIGH SCHOOL COMMANDS ATTENTION.

The industrial work of the Boise, Idaho, high school is attracting attention throughout the country. A practical turn is given the manual training work by using the boys in place of carpenters in doing the repair and cabinet work about the school buildings. For this work they are paid wages and allowed credit in manual training courses. During the summer a group of the boys did much of the finishing work on the new high school building, working under the manual training instructor as foreman and receiving both wages and school credit for the work. Cement sidewalks, concrete posts for school fences, and other cement work is done by the boys on the same plan.

A school farm of 40 acres with necessary teams and improvements is provided. In addition to this, the instructor in agriculture, who is also the county agent, has taken the contract of rejuvenating a neglected orchard and has leased a profitable bearing orchard. The land is operated by the boys who are paid for their labor. Through his relations as county agent, the instructor in agriculture is able to place all boys in the agricultural course who desire summer work on farms. There he can supervise them and allow school credits.

INTERESTING TECHNICAL POINTS ON GEMS.

By Frank B. Wade,
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(Continued from April Issue.)

Question 4.—*What species might be included in a mixed parcel of yellow stones? State clearly the characters upon which you would rely in distinguishing between them.*

Answer.—The principal stones which occur in fine yellow are:

1. Yellow diamond (usually called canary diamond).
2. Yellow corundum (variously called Oriental topaz, yellow sapphire, king sapphire).
3. True yellow topaz (Brazilian topaz, the fluosilicate of aluminum hardness 8, specific gravity 3.53).
4. Yellow quartz (almost universally called topaz in the trade, but softer and lighter than true topaz).
5. Yellow zircon (jacinth).

In the second division of yellow stones are listed those less commonly met with:

6. Yellow tourmaline (sometimes called Ceylonese peridot).
7. Sphene, or titanite.
8. Yellow spodumene.
9. Yellow beryl.
10. Yellow chrysoberyl (usually greenish).

To distinguish between these yellow stones one would, of course, have to depend upon difference of properties. The properties of precious stones which are most useful in distinguishing between them, because most distinctive and most easily tested, are: First, hardness; second, specific gravity; third, character of refraction (whether single or double; and, if double, the presence or absence of noticeable dichroism); fourth, character of luster. With uncut stones other properties—such as, fifth, crystal form and habit; sixth, character of cleavage; seventh, chemical analysis as determined by analyzing a fragment—might be used.

In the present case it is supposed that we are concerned with a paper of cut stones; and hence the last three tests are inapplicable except that, if flawed, some trace of the character of cleavage might be discerned and optical tests would give the probable crystal system.

Now to discuss in some detail how the first four tests might

be applied to the yellow stones of the question. The hardness test, when applied to cut stones, requires some skill to avoid damaging them. They should usually be tested only on the girdle (edge), as the least damage would result if a scratch were made along the edge of the stone. Uncut crystals of (*a*) diamond, (*b*) sapphire, (*c*) true topaz, (*d*) quartz and (*e*) feldspar will be useful in making the hardness test. The above minerals constitute the upper five members on Moh's scale of hardness, in which diamond was taken as 10, sapphire as 9, true topaz as 8, quartz as 7 and feldspar as 6. Most precious stones are as hard as feldspar or harder. Of our list of 10 yellow stones, the only one less hard than feldspar is sphene, which ranks 5½ on Moh's scale.

To test the hardness of a cut stone, begin by drawing its girdle gently but firmly across the flat, unscratched surface of the softest of our series of minerals—feldspar. The girdle should be held in the line of the expected scratch so as to do as little violence to the edge as possible. If a scratch seems to appear on the surface of the feldspar try to wipe it off with the finger, as it must be remembered that a soft mineral will frequently make a mark that may resemble a scratch on a hard one, but on wiping it it will be found to vanish like a chalk mark. If the mark persists it is a true scratch, and the stone being tested is as hard as or harder than the test stone. It is true that a corner or edge of a mineral will usually scratch a flat surface of the same mineral, but usually only with difficulty and by the use of considerable pressure. If the stone being tested is not the same in hardness as the test mineral the scratch will be made with ease on light but firm pressure. If the stone scratches feldspar it has a hardness greater than 6 and is not sphene. It might be any of the other nine yellow stones, however, as they are all harder than feldspar. The object in beginning with the softest test mineral is to avoid scratching the cut stone. As soon as it meets its equal one should stop, as its hardness has then been determined. With rough material the matter can be made more sure by causing the two pieces—the test mineral and the mineral being tested—to scratch each other. If they do so with equal ease they are, of course, alike in hardness. With a cut stone such a proceeding might require repolishing the stone, hence it is not advisable to try it.

The next hardest of our 10 stones (after sphene) is spodumene, which is rated as 6½ to 7 on Moh's scale. Hence, while it will

scratch feldspar it will fail to scratch quartz, or possibly in some specimens in certain directions (for minerals are often harder in some directions than in others) it may barely scratch quartz.

The yellow quartz would, of course (quartz itself being 7 on the Moh's scale), barely scratch the test piece of quartz. Yellow tourmaline is rated at about $7\frac{1}{2}$, and would hence scratch quartz more readily than the quartz scratched its own kind. But it would fail to scratch true topaz. Yellow beryl is nearly equal to true topaz in hardness and is ranked $7\frac{1}{2}$ to 8. It is harder than tourmaline and would scratch quartz, but would scratch topaz, if at all, only with great difficulty.

Next in hardness among our 10 gems comes true topaz, which forms the eighth standard test substance. Sapphire (hardness 9) would scratch it, and the topaz test stone would scratch it with difficulty but would also be scratched by it.

The yellow chrysoberyl has a hardness which is rated as $8\frac{1}{2}$. It scratches topaz but fails to scratch sapphire. The yellow sapphire would be scratched only by the diamond, except that the test sapphire might scratch it slightly and with difficulty.

The yellow diamond would, of course, scratch any of the other stones, even attacking the test diamond but suffering itself if much pressure were used.

It will be seen that some considerable practise will be needed before one can be sure of himself in making a hardness test; also that no single test should be relied upon in determining the character of a precious stone. If all of several tests, such as hardness, specific gravity and character of refraction, point to a certain species, one may be reasonably certain of the stone. As has been said in a previous article, color alone is a most unreliable test.

The second test suggested above was the specific gravity test. In this we seek to determine just how much heavier the stone is than a mass of water of exactly equal bulk. The stone is, of course, easily weighed, and in making a specific gravity test that is the first thing to do. It should, of course, be weighed in metric carats and hundredths to facilitate computation. This part of the matter is exceedingly simple and easy. The finding of the weight of an equal bulk of water is not so easy. It would be a matter of a good deal of difficulty to measure the stone and to calculate its bulk, say, in cubic centimeters (we use the metric measure of volume, since we are using the metric carat).

Now every mineral species has its own specific gravity, and in well-crystallized specimens, such as are used for gems, the value

does not vary much. Hence it affords a valuable means of distinguishing stones.

The fact that cut stones are in no wise injured by the specific gravity test makes it even more valuable.

In a previous article in this series the use of the simple expedient of reflecting direct sunlight from the interior surfaces of the cut stone onto a white card was described, and it can easily be found by this means whether a stone is singly or doubly refracting. Of our 10 yellow stones, all but the diamond are doubly refracting and will give double images of their facets on the card. Hence in this case this test is of little service. As regards dichrosim (the use of the dichroscope was explained on page 315, the diamond, being singly refracting, of course shows none. Yellow corundum gives two shades of yellow, a darker and a lighter yellow, in the dichroscope.

True topaz gives a distinct difference of shade, the particular colors depending on the specimen. Yellow quartz shows some difference of shade in the two squares of the instrument. Yellow zircon would not exhibit noticeable dichroism. Tourmaline usually exhibits strongly marked dichroism; sphene only in a moderate difference, especially feeble if the tint is light. Spodumene shows well-marked dichroism, beryl rather feeble, and chrysoberyl distinct dichroism.

As to the luster test, a trained eye is necessary to apply it. By luster we refer to the character of the light that is reflected from the surface of a substance. Some substances reflect light more completely than others, and hence have a more brilliant luster. Perhaps polished silver is as good a reflector as any common substance, hence its use on the backs of mirrors.

As precious stones are mostly transparent, they admit much light and reflect but little as compared to silver. The diamond is most nearly metallic in its luster, but still falls short of the metals in this respect. Its luster is so superior to that of most other gem stones that it is called adamantine luster, which means diamond-like. Every jeweler is trained to detect the peculiar luster of the diamond, and goes by that, perhaps unconsciously, more than by any other one thing in detecting a diamond by mere inspection. There are other qualities than mere brilliancy of reflection that help determine the kind of luster of a stone. Light may perhaps be caused to vibrate entirely in one plane after being reflected from the surface of a stone (physicists call this being plane polarized), and may then perhaps give a

faintly different impression to the trained eye. At any rate, no other stone looks exactly like a diamond in respect to luster. The zircon perhaps comes nearest to it, and hence may be said to have almost adamantine luster. It is this, together with its fire, that makes the colorless zircon such a close imitation of the diamond.

Of our other eight stones, sapphire has a very brilliant, vitreous (glassy) luster. True topaz and quartz both have vitreous luster, the true topaz taking, however, a somewhat better polish and hence having a slightly keener vitreous luster. Tourmaline also has the vitreous luster. Sphene has an almost adamantine luster; beryl and chrysoberyl both have vitreous luster.

The fifth question, which will next be taken up, asks: "Describe the following mineral species so far as they are used in jewelry: Beryl, chrysoberyl, corundum, diamond, jade, moonstone, spinel, topaz."

Question 5.—*What changes have been made in the unit of weight used for precious stones and pearls, and how is it related to other recognized units?*

Answer.—As everyone in the precious stone trade is aware, the carat has been for many years the unit of weight for precious stones. Its origin is apparently lost in antiquity, although it is alleged that it took its name and weight from the seeds of a variety of vetch, which seeds were very uniform in weight and convenient for use as a unit in weighing precious stones. However that may be, the carat has long been in use. Tavernier used the term frequently in his books of travel in the latter part of the 17th century. In these books he describes many gems that he saw or purchased in India, and translates their weights from the native units into French carat equivalents.

The carat has served its purpose sufficiently well, except that the carat of different countries has differed in value by amounts great enough to make big differences in money value of costly stones, when weighed by the different carats, if the price per carat were kept the same. Of course, in all practical business relations the value of the particular carat was, or should have been, understood by both parties to the transaction, but a uniform carat for all countries would have obviated the need for such a consideration of varying values. Recently such a uniform international standard carat has been adopted.

This was done by most of the countries of Europe before the

jewelers of the United States took united action on the matter. On July 1, 1913, however, the change was officially made in this country and the new carat has been universally adopted by American jewelers.

The new international carat is related to the unit of the metric system, the gram, in that it is exactly one-fifth of a gram, or, expressing it decimally, 0.20 gram. Now the metric system of weights and measures has reached such universal use in nearly all civilized countries except England and the United States that our new carat is founded on a nearly universal unit. Thus it can easily be compared and standardized anywhere.

With the old carat this was not so, and even in the United States different makers of balances and weights formely used slightly different weights for their carats. Another advantage that attends the use of the new standard carat is that it has been agreed to divide it into hundredths rather than into sixty-fourths, as was the custom with the old carat.

Thus computation of values of stones is greatly facilitated. The difference is similar to that which exists between computations in United States money and in English money. The division into one-hundredths makes computation vastly easier.

In regard to the weight of the new carat as compared to the old one generally used in the United States, it is a little lighter than the old one, which, instead of being .200 gram, was generally .2053 gram, or a little more than that.

Thus the old carat was about $2\frac{1}{2}$ per cent. heavier than the new, and if one wished to transfer from the old to the new system one would have only to add $2\frac{1}{2}$ per cent. to the old carat weight to get the new. In other words, the number of carats in the new system is $102\frac{1}{2}$ per cent of the number in the old system. A real example will make this clear.

Supposed it is wished to know how many metric carats a stone of $2\frac{1}{4}+1/16$ old carats weighs.

For convenience, first change the fractions to the decimal form: $\frac{1}{4} = .25$ and $1/16 = .0625$. Hence, $2\frac{1}{4}+1/16 = 2.3125$. Now get $102\frac{1}{2}$ per cent. of this: $2.3125 \times 1.025 = 2.3703125$, or 2.37 metric carat.

To change the other way (but there will now be small occasion for that), take .9756 plus times the weight in metric carats to get the weight in old-style carats.

For practical work conversion tables may be had gratis of several importers who have used them as attractive advertise-

ments. With these the equivalent values may be obtained at a glance. Such tables are, of course, based upon the arithmetical relation which has just been discussed.

Pearls have long been sold by the "pearl grain," which was not equal in value to the "grain" of avoirdupois weight but was one-fourth of a carat. With the change to the metric carat the "pearl grain" has now become one-fourth of a metric carat, or 0.05 gram in the metric system of weights.

(Concluded in the June Number.)

GOVERNMENT LENDS LANTERN SLIDE SETS.

The Agricultural Education Service of the United States Department of Agriculture has undertaken the preparation of lantern slides on agricultural subjects for educational purposes. These slides will be loaned for one week, exclusive of time required for transportation, on condition that the borrower agrees to pay express charges from Washington and return and to be responsible for slides lost or broken. It is also required that no borrower shall, under any circumstances, use slides for other than educational purposes.

The lecture sets should be ordered by the number or by the title of the set wanted. Each order should be limited to 50 slides. In ordering slides be sure to give the address of the express office to which the shipment is to be made. Applications should be made to the Chief Specialist in Agricultural Education, Office of Experiment Stations, United States Department of Agriculture, Washington, D. C., and should reach him at least ten days before the slides are wanted.

Each of the sets is accompanied by a syllabus for a lecture. The sets which are available and may be of interest to Minnesota teachers and extension workers, are:

Set I—The Preparation and Use of Illustrative Material for Elementary Agriculture—50 slides.

Set II—Improvement of Rural Schools—50 slides.

Set III—Rural Consolidated Schools—46 slides.

Set V—Community Work in the Rural High School—37 slides.

Set VI—Some Types of Children's Gardens in the United States—50 slides.

Set VII—Some features of High School Instruction in Agriculture—50 slides.

In addition to these sets there are available about 225 slides showing conformation of dairy and beef cattle, horses, sheep and swine, famous animals of different breeds, breeds of poultry, methods of handling poultry and buildings and appliances for use in poultry work. A list of these slides with call numbers for ordering will be sent upon application.

REPORT OF AN INVESTIGATION OF HIGH SCHOOL PHYSIOGRAPHY.

By Charles Emerson Peet,
Lewis Institute, Chicago, Chairman of Committee.

(Continued from the April Number.)

In What Respect Are the Results Least Satisfactory?

In answer to the question, "In what respect are the results in high school physiography least satisfactory?" the following answers were received: (The numbers in parentheses indicate the number of replies).

1. Student's knowledge of physiography superficial and not specific and definite. (8)

2. In the inability of students to apply the knowledge in the interpretation of out-door phenomena, in the bookishness of the knowledge and the failure to realize that the subject deals with realities. (11)

3. In the development of reasoning powers, powers of deduction, ability to study. Memory loaded, but thinking powers untrained. (7)

4. In the failure to develop interest in the subject, or an appreciation of relations of phenomena of climate to life, to processes to results. (3)

5. Not satisfactory in any respect. (2)

Reasons for Unsatisfactory Results.

In answer to the question, "What are the chief reasons for these unsatisfactory results?" the following reasons were given:

1. "There is not only lack of uniformity of aim, but worse than that a lack of aim, and, of course, lack of result. It is the old story—teachers in the other branches are expected to know their subjects, not so yet with physiography."

2. "Perhaps it is due to not enough field work, to not visualizing the stages of the process. The text is often learned when it is not understood.

"The teacher of physiography has difficulties without a thorough understanding of the subject and a wide actual knowledge of field interpretation obtained from field work, topographic mapwork and travel."

3. "It is too apt to be true that the high school teacher attempts so much that the immature student is confused and mystified, with the result that a positive dislike of the subject is engendered. This cannot help having a very unfortunate influence

upon the bearing of such a student when he engages in the more advanced college work. It sometimes takes several months to secure the interest of such a student, and his high school work is worse than useless."

4. "It is practically impossible to pick out any one thing in which the results are especially unsatisfactory—they are so generally bad. The worst trouble with the high schools is that poorly trained teachers, who know nothing about physiography, attempt to teach everything under the sun in the name of this science. What the teachers need is common sense, and *knowledge of the subject.* Then let them use a good textbook, cut out most of the foolish laboratory work, put plenty of field work in, and a reasonable amount of well-selected outside reading."

5. "There are two chief reasons for these unsatisfactory results. One is, that physiography is usually taught in the first year of the high school, when, of course, no subject which does not proceed farther is likely to be well grasped by the student. The second reason is that the subject is often taught by teachers who are totally unqualified to give good instruction in this line. With the exception of some of the high schools in the larger cities, there seems to be very little attempt to get teachers of physiography who are well prepared, and in the arrangement of the program, this subject is likely to go to the newest and least experienced teacher, or else is turned over to a science teacher, whose chief interest is other than physiography."

6. "Most science textbooks are written from the point of view of the technical scientists rather than that of the teacher, and they do not appeal to the ordinary boy or girl. There are too many subjects half taught in the graded and high schools."

7. "In the high schools physical geography if taught at all is in the first year, and, as State Inspector of high schools, I have had an opportunity to see something of its value. There can be no question that as now taught, following standard texts the work is of little value. It is not good discipline and comes down pretty largely to textbook recitation and memory drill, in which respect it is somewhat less valuable than Latin or other subjects with more definite method. The result is that school men, who naturally are keenly interested in having science in the high schools, are looking for something to replace physiography; and some very satisfactory results have been secured by introducing an extremely elementary course in general science dealing primarily with physical and chemical principles.

"To my mind the trouble comes in the content of physiography as represented by texts. It is altogether too geological. I am satisfied that if the topics treated under the head of physical geography should be confined to those which have direct bearing on man (for example, water supply, soil, forestry, weather, etc.) with a rather full development of the influences which these things exert on man, the subject would be found interesting and could be taught by the type of teacher with which we have to deal. The satisfactory results obtained in botany, zoölogy, physics, and chemistry in our schools would seem to indicate that the difficulty with physiography is not so much a matter of teaching or a disposition on the part of the student to avoid science, but that the subject as commonly outlined is inappropriate for first year high school students."

8. "The unsatisfactory results of high school physiography are, to my thinking, largely due to what is really a too advanced subject taught by persons who understand it imperfectly."

9. "Judging from my own experience and observation, I should say that the chief cause for poor results in the teaching of physiography in the high schools, at least in the West, is the lack of specially trained teachers. Many of those who are teaching the subject in this state and California had never even studied it before teaching it; and I have only occasionally met a teacher who has had any special training in that line. These statements are based (1) on my observations while teaching this subject, in both high school and university; (2) on my university experience with pupils from the high schools, and (3) on my observations in the schools, as one of the high school examiners for the university in this state."

10. "I have looked over the field in nearly every school tributary to this Normal and without an exception the fault is largely in the teaching. Usually the person 'having a vacant hour' is given the class in physical geography. Most of the teachers, in fact practically all the teachers are absolutely without any special preparation to teach the subject. As might be expected such teachers do not feel the need of adequate equipment and as a result the high schools have almost no laboratory equipment for the work."

11. "The principal trouble with high school physiography is that it is generally treated as a textbook science. There is not enough laboratory and field work given in connection with it. In case physiography precedes the study of the physical sciences,

it should be used chiefly to lead the pupil into scientific methods of procedure. Laboratory work of a simple kind ought to be given in order to give the student some scientific methods. As it is now almost nothing of this kind is done. In case of physiography following the study of the physical sciences, there should be more of an effort made to apply the principles of the other sciences to the study of the earth—for instance in physiography here at the college, I frequently give two weeks in the laboratory on weathering alone. I very seldom find a high school student who knows what oxidation is, or seems to have any conception of what is the effect of alternate heat and cold on a rock surface, and yet this is a most elementary physical matter. There is not enough practical application of the textbook to the facts of physiography."

12. "The course in high school physiography is generally unsatisfactory because of lack of laboratory facilities and apparatus. Few high schools are properly equipped for teaching the subject as it should be taught. Students are liable to form a dislike for the subject if an attempt is made to teach it without proper illustrative material."

13. "Unprepared teachers with only a book interest in the subject. Remedy—good teachers of fair degree of preparation, with a love for the work, and a desire to put the boys and girls in touch with their common everyday environment of air, land, and water, without specially 'preparing' or 'laying a foundation' for later sciences or for college, just to get the boys and girls to understand the things around them, not to 'prepare for life,' but to help them to live a fuller, richer, life while boys and girls."

Summary of the reasons given for poor results:

1. No definite aim.
2. High schools attempt too much:
   a. There are too many subjects.
   b. Too many things are taught under the name of physiography.
3. High schools are attempting the impossible.
4. Immaturity of the student and his ignorance of physical science and ordinary geography.
5. The subject is too difficult and abstract, and is inappropriate for first year work. The texts are too technical.
6. Teachers do not understand the subject.
7. Teachers do not have an interest in the subject.
8. Teachers are untrained.

9. There is too little field work. The work is too bookish.
10. The laboratory and illustrative material are inadequate.
11. Facts instead of principles are taught. Descriptions instead of solutions of problems are required.

SOME VIEWS OF HIGH SCHOOL MEN.

In order to get at the high school man's views, letters were sent to over two hundred instructors in physiography asking what in their opinion are the reasons for the apparently poor results. A few answers follow:

1. "I am afraid that the teaching of physiography is not apparently poor, but really so; and the reason is chiefly lack of preparation on the part of the teachers. In our own state, five years ago, among 180 persons teaching earth science there were just three who had done their college work along that line, and not more than twenty-five who had studied the subject in a decent college. That condition would not be tolerated in any other science. Then, too, the college men are just as often at fault as the student. They make no effort, for the most part, to use the foundation laid in secondary schools."

2. "Physiography is taught in the Freshman year and many students never refer to it again in high school. Even when they take other sciences it is scarcely referred to, especially as geology is seldom taught in our high schools. For four years I have given a course in general science. For five years previous to this I had given physiography. I consider general science better for a foundation course. After that, physiography may be given in such a manner as to dignify it as a science not as a foundation course. The pupils come to us with no previous foundation except in a few cities where the grades do some real nature study."

3. "Every teacher overestimates the amount of knowledge he thinks a previous instructor should have made perpetual in the minds of students. The high school teacher blames those in the grades and in turn the grade teachers attribute their inability to impart lasting knowledge to home conditions. The college man must consider that the high school student has probably not had more than a semester of physiography and that many years before: moreover it was forced upon him before he was old enough or had science foundation enough, to grasp the subject properly. There is no doubt in my mind that students enter universities sadly lacking in common sense physiographic knowledge. Nor can this be remedied until school authorities are made first, to

realize the importance of the subject; second, to engage competent instructors and pay respectably for the instruction; third, to establish certain prerequisites for the course."

4. "The reason for the poor results of high school physiography lies mostly in the limitations of the teachers. I have sat in three meetings during the past three years and have listened to the discussions of "The Problem of Physical Geography," and each time the conclusion was reached that physical geography is a most difficult subject to teach and that the poorest teachers are teaching it."

5. "I have yet to find a boy or girl, who, having chosen the science course, abandoned it after taking physical geography. The results of the high school physiography ought not to be poor and I cannot quite believe they are unrecognizable later in college courses."

RESPONSIBILITY FOR POOR RESULTS.

Of all the reasons for poor results the most commonly mentioned is poor teaching, and teachers poorly trained and poorly equipped in the knowledge of physiography. Twenty-six of the college men give these reasons. The questionnaire sent the college instructors included the question, "Is it reasonable to expect that young people fourteen or fifteen years old should retain much of the knowledge which they gained in the study of physiography but have not used for the three or four intervening years?" Thirty-eight answered, "No," and eleven answered, "Yes." If it is not reasonable to expect the young people to retain much of the knowledge which they gained in the study of physiography in the early high school years, should the responsibility for the student's lack of knowledge of physiography be assigned so unreservedly to poor teachers and poor teaching? If the poor results are in the development of thinking power the physiography instructor can hardly be held responsible at the most for more than about seven per cent of it, for physiography is only one of fifteen credits presented for entrance to college and the time given to it is not more than seven per cent of the entire time given to the high school training. For the poor results in thinking power the entire high school must be considered responsible rather than the instructors in one subject.

The remedy for the poor results of poor teachers is obvious. The poor teachers should be given opportunity to become good teachers. The apparently poor results of the good teachers and especially their good results may profitably be given further

study. The truth of the matter is, that we do not know how much of the good results recognized when the student gets to college are because of (1) the exceptional ability of the individual; (2) exceptional home influences; (3) skillful teaching; (4) ordinary teaching under fortunate circumstance; (5) knowledge made fresh by recent review, or acquired by a course taken in the maturity of the late high school years; (6) continuity of the science course and co-operation among the instructors in co-ordinating the subjects so that the student has used in later years what he learned in the earlier years of the course, or (7) a combination of these factors. The first two factors mentioned are beyond school control. It may be a satisfaction for us to know that good results are produced with these individuals but we cannot profit by this knowledge to improve our results. We know that skillful teaching late in the high school sometimes produces recognizable results. We do not know that skillful teaching in the first year of the high school ever produces, with the ordinary student, results recognizable in college.

The immaturity of the student, a lack of any previous experience in the study of science, and the lack of a follow-up system to give the student a chance to use his knowledge are recognized as some of the causes for poor results where the subject is taught in the first year.

Nine years ago a paper was read before this section[4] in which expansion of the course in physiography downward into the underlying physical sciences and upward into the study of geography was urged because of the interests of the young people and for the sake of improving the work in physiography. The recent introduction of elementary science courses, and courses in general geography shows that the need of this expansion has been widely felt. The value to the physiography of the elementary science course is mentioned by several of the college men, and its value for other courses is mentioned in the replies of several of the high school principals. If the physiography has lost ground because of the introduction of courses in elementary science, the leaders in our subject are alone responsible. The field was ours. We might have held it had they been willing to go outside the strictly orthodox limits of the subject. With the increase of Junior high schools and the introduction into them of a year or two of elementary science in what is now known as the seventh and eighth grades, we may, in the future, find ourselves in a po-

[4] See SCHOOL SCIENCE AND MATHEMATICS, Volume 7, page 425.

sition to produce good results in the ninth grade without going outside the strict limits of our subject. It will be just as necessary then as it is now to give the student an opportunity to use, in the study of geography, the knowledge he has acquired with us. It will be just as necessary then as it is now for us to secure the co-operation of our fellow teachers in science and in history, if we are to secure the best results. We have not secured this co-operation and the result has been that both knowledge and methods which we have attempted to teach have soon faded.

As teachers of the science which is now commonly in the first year of the high school, we are more interested in the work of the committee on a "Unified Science Course" in the high school than any other science teachers. We have more to gain through unification and co-ordination of the high school sciences than others. The work of the committee, of which Mr. James H. Smith and Mr. C. E. Spicer of this section are members, should not only be received with an open mind but should have our hearty support.

If the science work were unified as it should be there is reason to believe that both the methods and the knowledge acquired in the first year would be firmly established by the fourth year of the high school instead of having disappeared.

WHY SHOULD LIGHT COME FROM THE LEFT SIDE?

The well known fact that, when using the eyes for any near work, the illumination should come from the left side rather than the right is often disregarded. Let any one who considers the matter of little importance once demonstrate to himself the difference and he will never forget it. Take a pencil and paper and try to write while in such a position that the light will fall from the right side. The shadow of the hand or pencil or both is thrown on the paper in such a way as partly to cover the characters one is making. This necessitates a closer viewpoint and a conscious strain on the eyes. Now let the position of the writer be reversed so that the light falls on the work from the left side. He will notice that the shadows fall away from the work he is doing and leaves the field unobscured. In making the change he cannot help but notice the feeling of ease that immediately is experienced by the eyes. This applies to any other kind of near work in which the fingers work under the guidance of the eyes. This fact should be remembered in planning schoo'rooms, workrooms, offices and any places where steady close work is to be performed.

A DEBATE ON FERTILIZERS.

By A. W. Nolan,
University of Illinois, Urbana.

Some interesting correspondence is going on between a commercial fertilizer concern and some county advisers in Illinois and the Middle West. It may be of interest to readers of School Science and Mathematics, to give space to some of these discussions. A few letters follow showing the points in debate. The reader can decide who has the arguments.

Farm-Management Field Studies and Demonstrations.
Bureau of Plant Industry, U. S. Dept. of Agriculture & ———
Improvement Association, Coöperating.

————, Ill., Jan. 13, 1915.

Mr. ——— ———.

Dear Sir: Yours of the 11th inst. at hand and contents noted. I think I thoroughly understand your Try-a-Bag propaganda of mildly advising the farmers to jump into the extensive use of complete fertilizers in the Middle West. The farmer does not have time to experiment for himself neither is he properly equipped to do so. He pays some one else to do that and should be willing to accept their conclusions.

If the Agronomist or the County Agricultural Adviser is not qualified to inform the farmer as to the best systems of soil fertility and crop rotation he should practice, then he must necessarily accept the conclusions of the fertilizer manufacturer and his future as a prosperous farmer under such a system of fertility maintenance would be anything but promising.

The figures you quote relative to yields of corn in Illinois are misleading and I suppose you would like to have me conclude that the 18 per cent decrease in 1914 was due to the lack of sufficient fertility to produce a better crop. You either do not know or else do not care to state the actual conditions under which the crop was produced. The facts are, however, that a severe drouth affected the great corn growing section of Illinois and you can't produce a normal crop without sufficient moisture even if the soil be filled with fertilizer.

We Agriculturists of Illinois who thoroughly understand the situation are proud of the fact that the use of commercial fertilizer is on the decrease, and we are absolutely certain that the slight decline in crop yields is not due to a decline in the use of fertilizers.

We in the State of Illinois also find it profitable to make fertile soils still more fertile and believe in doing it in such a way that it will gradually increase and become permanent.

I am very doubtful if there is such a thing as the judicious use of complete fertilizer.

My statements are not at all dogmatic or sweeping when they are understood and it doesn't make any difference whether they are made by an Agent of the U. S. Dept. of Agriculture or by whom so long as they are correct.

It does not seem reasonable that an element of plant food should be added to a soil when that soil already contains an everlasting supply of that same element, and the same necessary system that makes other necessary plant foods available will make it available to the use of the crop.

Again it seems very unreasonable that a farmer should buy an element of plant food with which he is already abundantly supplied, it simply being necessary for him to grow the crops that will gather that element for him and at the same time supply the necessary organic matter for keeping his soils in good condition.

The practice of a permanent system of agriculture which does not include the use of complete fertilizers, but does include the use of legume crops and raw rock phosphate can be made just as intensive and much more profitable than the commercial fertilizer system.

I believe the economy of scratching over all creation to get 29 bushels of corn per acre would be about equal to that of an intensive method by which you got 58 or 98 bushels per acre and the cost of the commercial fertilizer used to produce the increase was equal to the value of the increased yield. The use of complete fertilizer is harmful because its use does not encourage the use of organic matter, thereby injuring the mechanical condition of the soil and at the same time encouraging the use of a little more fertilizer each year. If complete fertilizers contained all the ten essential plant foods I would not consider them harmful for that reason, but when their use encourages the leaving out of one of the very necessary practices of soil fertility then I know they are harmful. And if that necessary practice is carried out the use of complete fertilizer becomes unnecessary.

I doubt very much if the farmers in this State ever come to the general use of complete fertilizers and if they do we face one of the most serious periods of land ruin in the Middle West

that has ever been heard of. The use of lime and the plowing under of leguminous crops and the use of raw rock phosphate are certain to give just as quick results and more profitable ones than can be obtained by the use of a little bit of so-called available plant food and a larger amount of inert matter.

The farmer is pretty certain when he experiments with an automobile that he is going to get somewhere and the better informed he is on its management the less trouble and expense he will have and less time will be consumed in getting to his destination and so it is with a system of soil fertility that is economic, permanent and profitable, the farmer knows he will get there and have something to come back on.

I do not like to advise farmers to meddle with something that I know is not going to satisfy their wants, and, being an agent of the U. S. Dept. of Agriculture, does not influence the situation in the least. Furthermore I am not asking the Dept. of Agriculture to back me up in the statements I make; I have been able to learn a few things from my own observation.

Very truly yours,

(S) ——————.

County Agriculturist & Agent, U. S. D. A.

February 3, 1915.

—————— County Agriculturist & Agent of U. S. Department of Agriculture, ——————, Illinois.

Dear Sir:

Yours of January 13th is received; press of correspondence has delayed answer.

As an Agent of the Department of Agriculture you object to the "Try-a-Bag" propaganda on the ground that "the farmer has not time to experiment for himself and neither is he properly equipped to do so," and that, paying some one else to do it for him, "he should be willing to accept their conclusions." It seems to me that this is on a par with the teachings of certain churches, which claim that their members should not think for themselves, but accept the dogmas of the church. I shall be surprised if the Department backs you up in this stand, for it, along with about every College and Experiment Station, has been advising farmers to experiment for themselves, not alone as a means of finding out what they need, but as an educational step. In my day in the district school it was required that the boy should do the sum on the blackboard as the best way to teach him mathematics. You would have a paternal Govern-

ment think and act for him through Department and County Agents, and otherwise.

Our "Try-a-Bag" simply says to the farmer, "Don't take our word for it, but try a bag and find out for yourself. If you find that fertilizers do not work, or that it will not pay you to use them, then you have settled that question in your own way and on your own land." I think what you and a few others fear is that if the farmers of the Middle West should ever get to using fertilizers there would be no stopping them, and, as you view it, it would mean in the end, ruination of soil and hence a calamity—as if to use plant food, which Nature has provided in abundance (35,000 tons of nitrogen over every acre of soil and untold quantities of phosphorus and potash in the world) will be a calamity—as if milk, containing casein, sugar and fat, the three important elements of nutrition, is a calamity. Complete fertilizers containing the three chief elements of plant food—nitrogen, phosphorus and potash, can be misused as milk can be misused.

If, however, one will keep up the humus of his soil by using stable manure or plowing in green crops, he can do almost anything he chooses with commercial plant food. He can double and treble his crops on the same area, thus reducing the unit cost per bushel, and at the same time build up his soil. That has been the experience the world over and it will be the experience in the Central West.

You say, "I am very doubtful if there is such a thing as the judicious use of complete fertilizers." Perhaps you think fertilizers, like rum, are stimulants and for that reason there can be no judicious use of a stimulant, and in that view I am inclined to agree with you, for as a temperance man I doubt if there can be a judicious use of alcohol, but I *do not* accept the dictum that fertilizers are stimulants. They are as much food as milk and beef are food, and therefore I think there can be a judicious use of plant foods, as there is a judicious use of human foods.

You say, "It does not seem reasonable that an element of plant food should be added to the soil when that soil already contains an everlasting supply of that same element." That statement seems reasonable, but suppose you have exhausted the amount which is available of that element, and Nature does not render it available fast enough to produce maximum crops, then what are you going to do? The crop tells you what it finds, but not what is left behind. The horse knows that he had a good

meal of oats at noon, but he does not know whether there is another meal in the bin for supper. There are undoubtedly great stores of potential fertility in the Middle West soils—all soil analyses prove it, and yet the average yield of wheat is 14 bushels, and of corn 28 bushels, when under more intensive systems of agriculture, including the judicious use of a little plant food, it should be in normal seasons, 30 bushels of wheat and 60 bushels of dry, merchantable corn per acre.

I believe in a permanent system of agriculture which includes legumes, rock phosphate, lime, etc.—all good, but too slow; we must grow bumper crops this year as well as five years hence. The President in his Address to the United States Chamber of Commerce (Feb. 3rd) says, "We must produce more per acre" —in effect, "Speed up!" This can be done by supplementing permanent agriculture—potential fertility, with some quickly available plant food in commercial forms.

I am aware that Illinois had a severe drouth in 1914, and probably that was the cause of the 18 per cent decrease in her corn crop for that year, but the ten-year period ending with 1914, which was not unusually affected by drouth, showed a decrease of 9.2 per cent from the ten-year period ending 1910 (See Bulletin 641). So your boasted permanent agriculture has not yet materialized in the general uplift of the average. Why? Is it not because your soils are lacking in the needed available fertility?

You are proud of the fact that the use of commercial fertilizers is on the decrease in Illinois. Some day you will be proud of the fact that by the judicious use of them you are not only improving and increasing your yield, but maintaining the permanent fertility of your soil. Illinois cannot be an exception in the world. What other countries have done and are doing with commercial plant foods, she will do and by so doing she will win her place back in the Garden of the World.

Just think of it, in order to safeguard the next crop, the German Minister of Public Works has just issued an order to the effect that fertilizers and all materials required for their manufacture, shall be rated on the railroads as "preferred freight," and since the box cars are now required for other purposes, the Government will provide tarpaulins to cover fertilizers shipped in open cars. I think if the Government of Illinois should declare that fertilizers were "preferred freight," and should provide tarpaulins for their shipment in open cars, something would happen at Urbana.

In order to husband the potash of Germany for their own soils, a decree has just been issued forbidding the exportation of *all* potash salts, but no doubt she would be glad to supply potash salts to us in exchange for our phosphates, for she imported in 1913 a million tons of phosphate (about half of it from the U. S.) and converted it into acid phosphate instead of using it raw. What a foolish country! If she knew what a few of our noted agronomists know she would not dissolve phosphate, and she would not apply potash to her soils already rich in potential potash. She would just follow their teachings and *perhaps* she would be able to raise 88 per cent of her foodstuffs in the shape of rye, oats, barley, potatoes, etc. (?)

Remember, although Great Britain has declared wheat contraband, that it is still going to be in great demand.

Remember, wheat does its principal feeding in 60 days—"Feed me, and I will feed you."

Remember, that wheat top dressed this spring—fed with a little of the milk—easily assimilated plant foods—which Nature has provided, may return twenty or thirty fold.

Therefore, "Try-a-Bag." It may not pay you, and then you will surely have something to talk about. Again it may pay you; then I feel confident you will report the facts as you find them. I am quite willing to leave it in your hands. We are both seeking the common good of agriculture, for as it thrives we all thrive.

Seek ye first righteousness, and then fertility.

"Try-a-Bag—for the land's sake."

Yours truly,

(Signed) —————.

CONSULTING THE PHYSICIAN WHEN YOU ARE WELL.

The large majority of people, in this country at least, seem to think that the function of the physician is to endeavor to restore one to health after one has some malady fixed upon him and very frequently after it is too late for any physician to hope to effect a cure. It is, of course, all right and proper to consult a physician when one is ill, but many of our ills and diseases could be warded off and prevented, if we made it a point to consult a reliable physician at least twice every year. He would frequently be able to detect the beginning of serious difficulties and prescribe a remedy and course of treatment which would ward off the trouble. Likewise he would be able to advise his patient as to his diet, amount of exercise and the kind that he should take in order to keep in good physical health. If this scheme were carried out by people generally, the longevity o fthe inhabitants of the United States would unquestionably be increased several years. See the physician while you are well. Do not wait until you are prostrated by this or that disease.

LIVE CHEMISTRY.

By H. R. Smith,
Lake View High School, Chicago.

Probably the most highly regarded form of vocational training today is that generally called "part time work." The student alternates between school work and real shop work. The first attempt of this idea in the study of chemistry that has come to our notice is that, in the Gary, Ind., schools, where Mr. S. G. Engle is Director of Sciences in the schools and chief chemist in the Municipal Laboratory. The City Food Inspector works under the guidance of the Municipal Laboratory.

Relation of School and Municipal Laboratories.

By S. G. Engle,
Gary, Indiana.

Time has come when every wide-awake city either has installed a municipal laboratory or is considering its installation for the safeguarding of the food and health of the community. To expect the state to accomplish this is asking too much for several reasons. To get the best results, the state would employ hundreds of inspectors and a larger number of analysts to take care of the work, but even then there would be much time lost while the samples were in transit. The state, as a whole, can get better results if the laboratories be near at hand. To get the desired results with the inspection of the perishable foodstuffs, such as milk, meats, vegetables, the inspector must be at hand all the time, for this is a division of the work that needs constant attention.

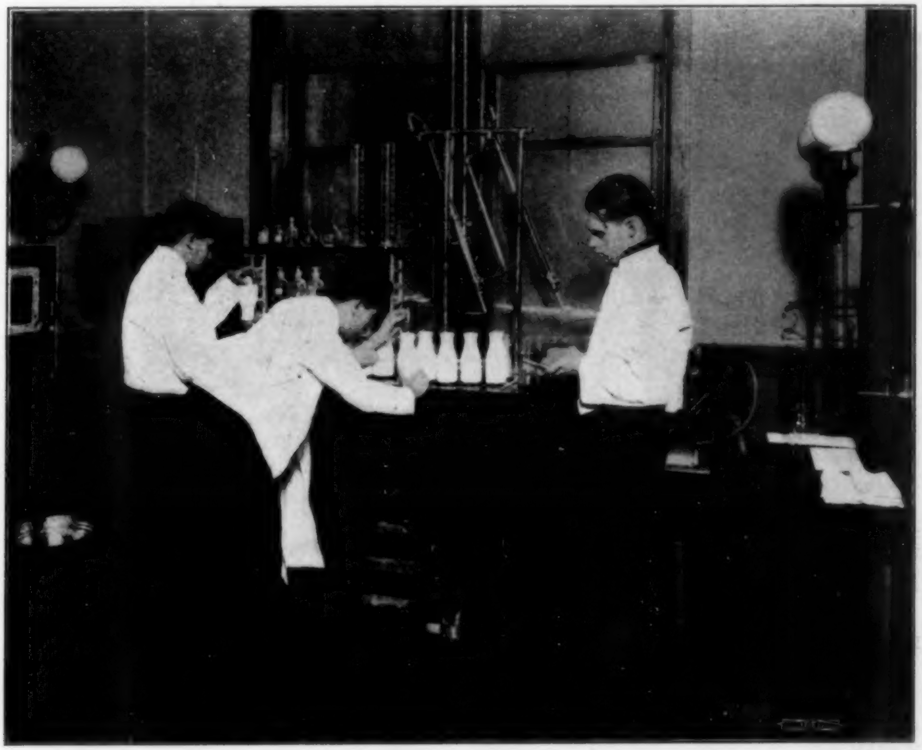
To accomplish the result for which it was created, the State Food and Health Laboratory should be a place for research. To permit this development, the cities of the state must take care of their own routine laboratory work and inspection. As it is now, the state laboratories are overloaded with this routine, with little or no time to devote to the special conditions which arise from time to time.

In dealing with contagion, the local laboratory is much to be preferred. It is highly important in contagious diseases to have the proper diagnosis as quickly as possible, not only to properly administer to the patient, but to protect the public from further spread of the disease. Most cities think nothing of the money they spend to prevent the loss of property by fire, or to prevent the loss by robbery, and for this purpose the most modern equipment is

procured. Auto-trucks are replacing the trained and speedy fire horses, and the cities are dotted with fire signals and police call boxes. It is another case where time is considered money, but what about the loss of a life, which the law values at $10,000? Why should we not be just as anxious to be efficient in this case? A physician may be called on a case where an infectious disease may not be developed to such a stage where diagnosis can be made with certainty, and until quarantine can be established the friends are often permitted to come and go, with the result that the disease is rapidly spread. With a laboratory at hand, it is often possible to have the diagnosis confirmed within an hour, and thus save all the trouble and expense of the weeks that follow. The health of the community should at least have the same consideration as the fire and police protection, and this can only be done by the installation of municipal laboratories. To send the specimens to the state requires too much time. To get the results from the state, even though they be telegraphed, takes from twenty-four to forty-eight hours. We would not call this efficiency in other departments, neither is it efficiency in the health department. Efficiency in the health department can only be secured when the results can be obtained quickly and often.

The demand for pure food in a community is largely a matter of education, and since this is true, the real place for the food and health laboratories is in connection with the public schools of that community, either in the same building or in one at hand to be used by the older students. With the health work conducted in this way, the students come in daily contact with the food and health conditions, and in time grow to demand the best. The surest way to make a merchant sell pure food is to educate the people as to what is pure and wholesome. Then they will demand that for which they are paying. In this way, they will soon get unadulterated food and food which is not preserved with unlawful preservatives. The public has become accustomed to accept that which is given them by the merchant, and, if the price be about what they think they can pay, they are content. Education is changing this condition and the people are demanding to know what they eat and its effect upon the health. As this demand becomes greater, it will become much easier for the inspector and the health departments to enforce the health and pure food ordinances. Living daily with the problems of the inspectors and the municipal laboratories, the problems with which they have to deal become the students' own problems, and then the real education and betterment begin.

The cost of maintenance of the municipal laboratory, which should be a secondary matter, can be greatly reduced by this combination. Why should the city equip and maintain the laboratories of the schools for educational purposes and duplicate another for the food and health work for the same purpose? In other business we would say this was a lack of economy; then why not here?

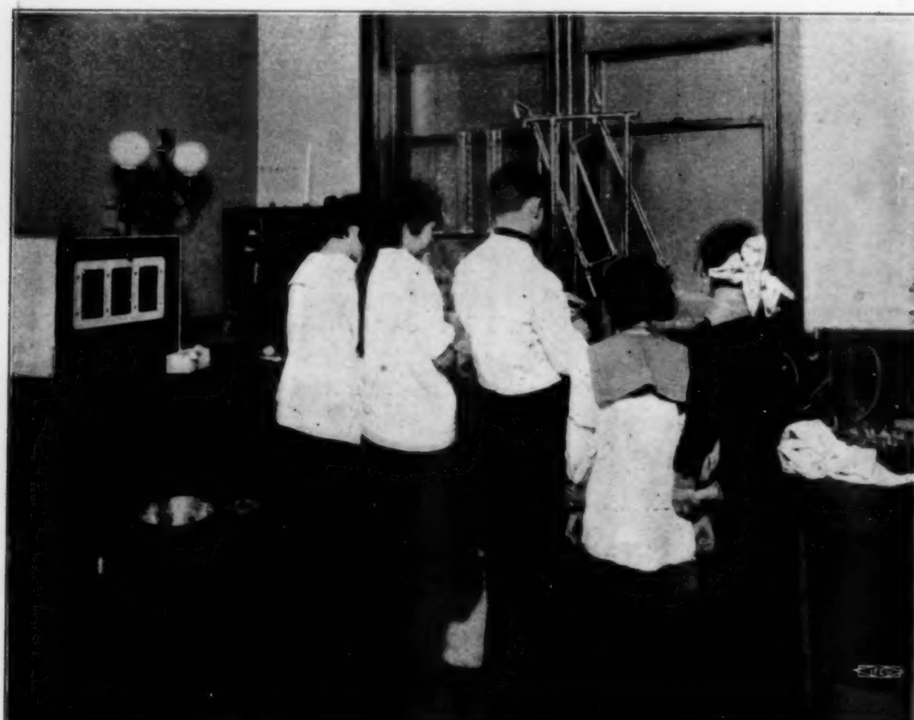


SENIORS TESTING CITY'S MILK SUPPLY.

In Gary we think we have made a step in the right direction, for the municipal and the school laboratories are under the same supervision, although the laboratories are not in the same building. Students are permitted to sign for a period in the food and health laboratory just as they would in any other class, and receive credit for it. At present we have five who have elected this work. While there they first act as assistants, then are permitted to manipulate, being closely watched until they are proficient. We have found that high school students in chemistry soon become proficient in making the routine milk tests, which

are for specific gravity, condition of cleanliness, butter fat content, for preservatives and bacterial content. On account of the technics and the greater need for care in the manipulation, it takes a little longer to teach them to make the bacterial count, but the more careful students soon master this part of the work.

The same thing is true about the testing for sanitary water. Students, who have had the subject of titration in the regular school work, can easily learn to titrate the chlorine content in

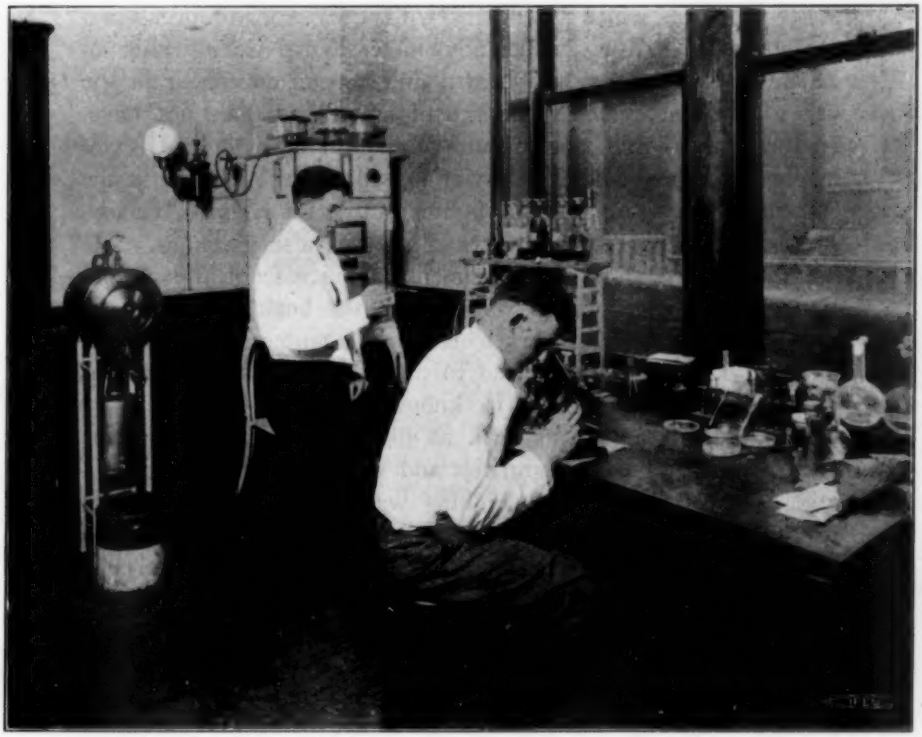


A Senior Titrating the Chlorine in Drinking Water.

drinking waters. A short time ago, a physiology class was studying the sanitary condition of the city, and four of the girls, to whom the subject of the city's water supply had been assigned, came to the writer to inquire how and what tests were made. In reply, the writer told them that instead of telling them the method, he would permit them to come to the municipal laboratory and there watch the tests. They came on one Tuesday on which day one of the seniors, who had become proficient, tested the chlorine content for them. They also watched the sowing

of the fermentation tubes for gas forming coli, and the preparation of the plates for the bacterial counts. On the following Thursday, they returned and were shown the fermentation tubes, also the way in which the counts were made. They took notes on the work and from these wrote the description of the tests. This method presented the work in such a manner that it meant something to the girls.

With a little training, we find that the students can make some of the more simple pathological microscopic slides, espe-



A Senior Learning to Prepare a Slide for Tuberculosis.

cially from the direct smears. The one made from a direct smear for tuberculosis is one that seems easily made by the high school student. We never accept the result of a pathological slide made by a student without first corroborating the same, for there is too much at stake. Just what the high school student can and can not do in the health laboratory is a question frequently asked. There is practically nothing he can not do, but

the length of time it takes for him to become proficient enough to work independently depends upon the individual student.

In order to view this subject from the student's point of view, I asked a student, who has worked in this combination, to write a statement as to what he thought of the work and the benefits derived. The following is his statement:

Work in Municipal Laboratory for Chemistry Students.

The classes in Chemistry of the Emerson School are very fortunate in having an excellently equipped laboratory in which to work. But we members of the classes who expect to follow a life work, in which Chemistry will be of daily or occasional use, are accorded the further advantages of the Gary Municipal Laboratory. Here we may learn and become proficient in the use of apparatus which the school laboratory does not have. In the tests of milk for instance, the most efficient centrifugal machines are at hand, the heavier ingredients are thrown to the bottom of the tester and the lighter butter fat rises to the top.

An opportunity for microscopic work is also given us. We learn to prepare slides and specimens for microscopical examination, and thus come into contact with the health work of the municipality. We also learn to test and examine sputum, blood, and the body excrements, and to distinguish healthy conditions from diseased. We obtain a knowledge of the use of many other kinds of apparatus such as the Polariscope, for testing sugars and syrups for impurities and adulteration; finely graduated burettes, for testing drinking water, and the quantitative tests of many articles; and many other pieces of intricate apparatus. This all helps us to understand, and use the school apparatus intelligently. It also gives us the opportunity to learn to test a great variety of food stuffs.

On first entering the municipal laboratory we watched the others work, then assisted, and then assumed initiative. We are allowed to use the fine and delicate apparatus of the laboratory in the solving of the actual and important questions of the health department, and because of the accuracy required in this work we learn to be more accurate in our school Chemistry.

BEN E. JOHNSTON, '15.

The food and health of the community can be made of vital interest to the student in school, and since interest is the first step toward education we have the proper condition for the education which will bring about a better condition physically, morally, and socially.

THE ATTITUDE OF THE HOME TOWARD "SCHOOL" HOME ECONOMICS.[1]

By Mrs. W. S. Hefferan,
Chicago.

In the early days of education in this country the schools only had to take care of the formal education of the child in the three R's—as his industrial education was given in the home. But social and economic conditions changed and to the school curriculum were added the three H's—training of the hand, head and heart (mental, manual and moral). Then society, not satisfied, added to the school's burden the three C's—the development of conduct, character and citizenship, and today we have a class of parents, who, by their attitude, demand of the school the three B's—body, brain and bringing up. They feel that if they feed, clothe and shelter the child a Kind Providence and the public school will do the rest. It is a situation which educators must meet and it is high time they called in the school patrons to urge them to undertake their full share of the training of the child.

One of the best means a teacher has to judge of her work is through its reaction in the home. This is true of the teaching of any subject but especially so of Home Economics. How can the teacher of Home Economics project her work into the homes so as to overcome apathy and indifference there? For the problems of the home are the problems of civilization and whatever exalts the home is of vital importance to the nation. The chief problem of the home is the problem of woman, of her daily employment and her attitude toward domestic life. If any considerable number of civilized women become imbued with the idea that domestic life is "slow," that marriage is undesirable, there is peril to the nation.

In former days woman in the home was the partner of man and not his competitor in his struggle for a livelihood. Her contribution toward the support of the family, in the matter of wise spending and saving the money was as necessary as his and no less strenuous. But the advent of machinery and industrial changes have taken away many of her former duties and we have the striking result of over 5,000,000 women in the wage-earning occupations.

Women have the right to enter such occupations outside the

[1] Read before the Home Economics Section of the C. A. S. & M. T. at Hyde Park High School, November 27, 1914.

home but there is danger of making too broad the pathway leading away from the home and thus obscuring the chief practical department of women's endeavor.

It seems to me there is a real menace in the army of girls pressing into shop and mill and factory and into forms of employment less menial, in a sense, but no less dangerous to health and the home instinct, namely, the nerve-wearing occupations of saleswomen in the great department stores.

Many of these women are working from necessity, but most of them seek wage-earning occupations from choice. Not being obliged to contribute to the support of the home, they spend what they earn upon themselves and thus acquire new standards of living expense and domestic life becomes more and more an impossibility.

This industrially independent young woman will not marry a working man because with his income she cannot live up to her expensive living standards.

Young men are turned from matrimony for the same cause. Whatever deters man from marriage through his inability to meet the demands of extravagance or the unwillingness of the young woman of his own class to surrender her income to share his, tends to social demoralization. There is of course a time in the life of many young women when, for the time being, it may be necessary or desirable that they have an independent occupation. This fact makes the problem a complex one. The home and the school together must solve it by instilling into the minds of the young girls the very great importance of training for home-making, and, with the right standards, we would find more of these girls willing to give up the $6.00 a week and accept partnership in the $15.00 a week of the worthy young man who would gladly give up the lion's share of his income for the comforts of a home. The young woman would also enjoy a home but she shrinks from that for which she has had no training.

Whatever may be the temporary ambition of the girls in our elementary and secondary schools the fact remains that we must not ignore the eventual demands that will be laid on these same girls and it is incumbent upon both home and school to do all things possible while the girls are in the school to get them ready for the duties of womanhood.

I feel that the course in Home Economics should be made compulsory for all girls entering the secondary schools—for

some time in life every woman has in some way to do with the feeding, clothing and nursing of mankind and with the proper spending and saving of money—fundamentals in man's existence.

There are well-equipped Home Economics Departments in High Schools not used to their capacity because, where the course is elective, many girls prefer a study hour to keep their evenings open for pleasure. Here again the home is at fault. What influence can be brought from the home side to induce the girls to take the course? One way is to ask the mothers to come together at the school to make them realize that instruction in the homes has broken down to a large extent, that the housewives of the present did not receive proper training in their youth, and they cannot successfully impart to the oncoming generation knowledge of an art in which they themselves are not proficient. They must be made to realize that the old conclusion "Girls will pick up domestic skill from their mothers" is exploded. There are 57 varieties of mothers—the genius mother, the journeyman mother, the suffrage mother and the delinquent mother, as some one has classified them. Then there are the mothers who are entitled to write degrees after their names, i. e., B. A.—may mean blatantly argumentative; B. C.—barely connubial; M. A.—moderately affectionate, and L. L. B.—lady loving bridge. Then again B. A. may mean bread artist; B. C.—best cook; M. A.—matrimonially able, and L. L. B.—lady loving babies.

Both mother and daughter must be made to realize that the new study of Home Economics means science added to a long-belated industry showing better methods—new apparatus—great improvement. They must be made to realize that the study of Home Economics is the most far-reaching and fundamental of all studies because it has to do with the food of mankind which is intimately connected with health. The answer must be given to the statement that cooking will follow candle-making out of the homes by showing them that bakeries and laundries have been far from satisfactory as to cleanliness and reducing cost.

The complaint is made, and justly, that the girls who seem to look upon the baking (at school) of nice little loaves in bright new pans, in a gas stove, look upon the work of making bread at home as drudgery and the mother is willing to work away wearily, in the kitchen contented that her daughter is being educated while studying her Algebra.

It seems to me that one way to meet this problem is to pro-

ject the school into the home and give school credit for home work. Supt. Alderman of Oregon was the pioneer in this work and now almost all the schools of the state are doing it. He was instigated to start it by the indifference of one of his High School pupils who could not be interested in her school work. So he asked the pupils to perform 10 problems at home one evening—five to be out of the Algebra and the other five—to help get dinner, help wash dishes, help get breakfast, wash breakfast dishes, and make one bed. Mary was waked up because some one was willing to take into account the work she could do.

In the schools of St. Cloud, Minnesota, a very successful experiment has been tried in giving school credit for home work—16 units are required for graduation, 15 of which shall be regular school credits. Then for the other credit they may perform any one of the following tasks, to be certified to by parents or exposed in an exhibit: making beds daily for three months; making waist, dress or other wearing apparel for the family; preparing one meal alone daily for three months; cooking meat or eggs in three ways and making three kinds of cake with exhibit. The boys were given such tasks as installing three or more electrical conveniences in home; taking care of automobile, etc. What is done by thus recognizing home efficiency? 1st—it unites the school and the home; 2nd—connects the work of the school with life going on outside; 3rd—encourages the pupils to spend their time at some useful occupation. It directs the work of the child toward everyday practical tasks. It trains for service, not merely recognizing the acquisition of knowledge. Thus the children become better fitted for complete living. The ideal is industrial and social and makes for home efficiency.

Thus working with the mothers to raise their standards in regard to home economics and stimulating the daughters by a sane recognition of the work they do at home, the result may be obtained which Sarah Arnold so devoutly wished for when she said—"The time will yet come when we will say to our girls, 'You cannot leave school until you have received the elements of the training that enables you to undertake home making and home-keeping—to secure the essentials of the American home.' "

SCHOOL CREDIT FOR HOME WORK.

By Emma Conley,

State Inspector of Domestic Science, Madison, Wisconsin.

The subject of school credit for home work has been discussed so frequently of late that no preliminary statements are necessary to explain what is meant by the term.

The plan was not started to carry school ideals into the home and improve it, but rather to form home ideals at school and improve the girl. The average school girl has no tasks, duties, or responsibilities at home; she takes no interest in general household affairs; and she has too much leisure time, which must be spent either in idleness or amusement.

The girl is not to blame for this, for home conditions have changed so radically in recent years that very little work is demanded of the girl, though much work still remains to be done at home.

Until recently, schools have never encouraged pupils to become interested in outside work, except when encouragement was needed to make schooling possible. Pupils who were obliged to remain at home to help on certain days or at certain seasons, were not always commended for their obedience to parents, or readily assisted to make up work which they had missed. Often teachers scorned the home methods of doing work, as insanitary, old fashioned, inaccurate, while the parents with greater reason for doing so, found the pupils careless, inefficient, and unable to undertake the responsibility for some of the simplest household tasks.

The contempt, distrust and variance between home and school can be easily overcome when parents and teachers realize that neither home nor school, alone, can take the burden of responsibility for training children, but that school and home must become acquainted, lose prejudices, overcome intolerance, and work together to carry out a system for training boys and girls which will develop character and train for some useful work.

The home economics teacher must realize that though her subject is not more than a quarter of a century old, as a school subject in this country, the business of home making, including cooking, sewing, spending the income, rearing children, and caring for the sick, has been carried on successfully for centuries and will be carried on, even though home economics is no longer taught in schools. She must realize that the average mother knows infinitely more about these subjects than she does, and that if the teacher

can interest the mother in school credit for home work, the girl's field of knowledge will be broadened materially.

Then, too, the school furnishes but a limited opportunity for putting into practice the principles and theories presented in class. A single cooking lesson given at school, at which two girls work together and prepare but a fraction of a recipe, under the direct observation of the teacher, is of little or no value unless the process is repeated again and again at home, where the girl assumes full responsibility for the task and where skill, accuracy and knowledge are developed.

The school has not time, money, or facilities for this practice work, nor would it be desirable to do the work there. Home conditions are necessary to give the work its true setting and to show its relative value in the general scheme of housework.

School credit for home work is advised and encouraged in home economics classes in Wisconsin for the following reasons:

(1) To occupy leisure time formerly spent in idleness.

(2) To give training in home management and to develop character by having the girl assume duties, tasks, and responsibilities.

(3) To arouse an interest in the problem of actual housekeeping.

(4) To dignify home work by making it equivalent in value and importance to school work.

(5) To share with mother some of the burden of home work.

(6) To interest parents in school.

(7) To interest teachers in the home life of the pupils.

(8) To furnish a real laboratory for practice, and for perfecting through such practice the knowledge gained at school, so that such knowledge may be co-ordinated into the general plan of daily housework.

(9) To acquire the skill and mastery which comes through practice of things learned at school under close supervison, and which pupils should undertake again, without supervision, to find out what has been really learned.

(10) To bring school and home more closely together so that both feel responsible for the training of the girl as the future homemaker.

The system recommended by the writer originated in Chippewa Falls, Wisconsin, and has been in successful operation for the past two years. It was introduced into over a hundred cities dur-

ing the past year and it is firmly established as part of the home economics work.

The inspector visited Chippewa Falls one Monday morning and found that all pupils who entered the domestic science classes left a folded paper on the teacher's desk. On examination of some of the papers they were found to consist of a complete record of all the work done at home, by the pupils during the past week. In every case the record was signed by the mother. The inspector asked for, and was given, one week's complete file of records for 6th, 7th, 8th grades and for freshman year of high school, probably one hundred records in all.

Two papers contained no report. One paper stated, "I did no work at all last week, I was sick." The following statement was found on one seventh grade report, "I made a batch of doughnuts, they got good, at least my father said so."

Another paper contained a daily record of work and among the items given for Saturday were the following, "Threw a load of kindling wood into the cellar, took my music lesson, and had my picture taken."

The accompanying record is a fair average of those secured and is given here because it shows the wide range of possibilities in the work,

HOUSEKEEPING.

Lura Case.

(This report is given exactly as it was received.)

I kept my room in order and made the beds each day.

I swept the upstairs floors once, and swept the kitchen eight times.

I washed the dishes on an average of twice a day.

Helped to keep the front rooms in order.

Dusted the parlor four times.

Scrubbed the kitchen floor Saturday and washed the windows in the parlor and kitchen.

I sewed the French seams in underskirt and ripped the tucks out of another skirt. Embroidered on a towel. Darned one pair of stockings. Put a patch on two corset covers and drawers.

Made a Persian girdle for my new dress and a chiffon vest.

Cooked some cranberries.

Baked a cake; result good.

Filled two cakes—one good.

Baked oatmeal cookies—one tin was baked too hard.

Tended to the frying of doughnuts.

Popped three batches of corn.

Fried tenderloin twice—good.

Got three meals.

Purchased postal cards, rubbers for mother, postage stamps, 4 yards of ribbon, chamois skin, sausage.

Ordered butter twice, lard, grapenuts, oranges, matches, cranberries, oil.

I helped mother with my dress, such as basting the seams.

Hung some clothes up this morning and all of the clothes last Monday.

(Signed) O. K., MRS. CASE.

Credit is given for any kind of work done at home, based on time devoted to the work, on responsibility taken for the work and on knowledge used and acquired to accomplish the task. The ultimate aim of the teacher is to have the girl able to take complete charge of her home for a day or week at a time and to assume full responsibility for everything.

Weekly reports, sometimes itemized for daily work, are written out by the pupils, signed by the parents, graded by the teacher, and the grade is averaged with the domestic science grade for the month. One-fourth or one-third credit is given for home work and the remainder for school work. These records written on papers of uniform size, are posted for the week in a conspicuous place in the school kitchen, where they are accessible to all pupils for comparison.

This arouses a friendly spirit of rivalry and a desire to do good work. Papers are filed afterwards at school for as long a time as the teacher cares to keep them.

The question is frequently asked, "How can a teacher be sure that the paper handed in is an honest record of work done?" The answer is that few mothers would sign their name to actual untruths. The only thing which should be carefully considered is the authenticity of the signature. Another question asked is, "What would you do to a girl who does no work?" It is a surprising and gratifying fact that of the thousands of girls handing in these reports very few do no home work, after the plan has been fairly started. Industry and thrift are contagious and girls like to do things for which they are commended at school and which will raise their standing.

When, however, an occasional case is found of a girl who does no home work a valuable record is on file at school to convince parents when the pupil fails in subjects or loses interest in school, that the home has not done its share in training the girl to assume responsibility.

There are several good ways of carrying on this home project work, and each fulfills its purpose if it interests each pupil in some useful task, especially if it interests girls in the vocation which they will follow for the greater part of their lives.

This system explained at length, is recommended for grade and high school classes in home economics because it is simple, can be made to include all lines of work which may interest pupils, takes account of tastes and inclinations of the various girls, and because it aims to complement the school work and perfect the knowledge and skill acquired in the home economics classes.

THE SLIDE RULE CONSTRUCTED WITHOUT LOGARITHMS

BY A. H. FENSHOLT,
Engineer of Tests, Kimble Electric Co., Chicago.

The value of the slide rule in making rapid, approximate calculations has been generally recognized by engineers and their assistants. The facility with which the slide rule may be manipulated is due mainly to its small size and light weight, making it a true pocket instrument of unlimited usefulness.

In order that students in technical schools may be informed of the advantages derived from the use of the slide rule, a special point is usually made to introduce the rule with the work in logarithms. This doubtless is the logical place to study the slide rule, because it demonstrates in a practical way that multiplication is effected by addition of exponents of numbers to a common base.

A general belief exists that the peculiar subdivision of the slide rule scale cannot be clearly explained without the use of logarithms. As a direct result of this belief, a large number of engineering students, in evening and other extension schools, have not had the slide rule explained to them, merely because they are not acquainted with the logarithmic table. To such students the construction of the slide-rule scale is associated with much mysticism. The following analysis was developed in order that the slide rule scale might be made clear to such students without the use of advanced mathematics.

The commercial slide rule consists of two different scales, one being double the other. Since they differ only in size, the following analysis gives only the method of drawing the lower scale of the commercial rule. If the lower scale can be made correctly the upper scale, being merely two scales in duplicate, can be drawn without difficulty.

The slide rule is essentially a machine for multiplying and dividing numbers. It cannot be used for addition or subtraction. In designing a slide rule it is necessary to consider it as a multiplying machine only, ignoring entirely its use in division, because if the slide rule can be made to multiply, it can also be made to divide by simply reversing the order of manipulating the rule.

The construction of the slide rule will require a strip of wood or paper, which will be known as the "main scale," and a smaller piece of wood or paper, known as the "index piece." Upon the

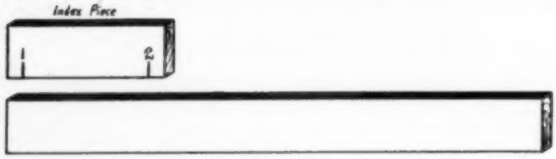


Fig. 1

Fig. 2

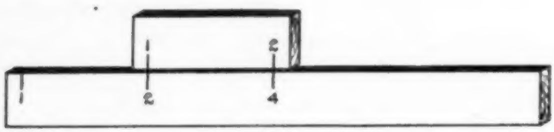


Fig. 3

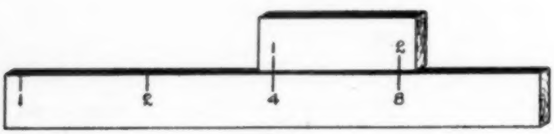


Fig. 4

Fig. 5

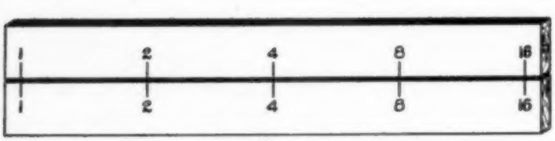


Fig. 6

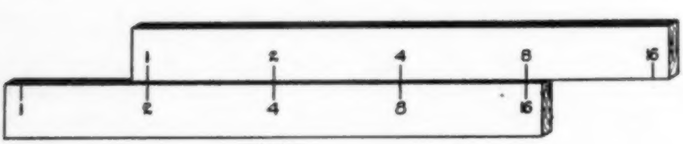


Fig. 7

index piece is placed a vertical line, marked 1, and at any convenient distance to the right of 1 is placed another vertical line, marked 2. (Fig. 1.) The distance between 1 and 2 is immaterial.

The index piece is then placed parallel with the main scale at one end (Fig. 2), and the marks on the index piece are transferred to the main scale. The marks on the main scale are also designated as 1 and 2, respectively.

The index piece is then moved to the right until No. 1 of the index coincides with No. 2 of the main scale. (Fig. 3.) It is then possible to multiply 2 on the main scale by 2 on the index. Therefore under No. 2 of the index should be placed the product, or 4.

By moving the index piece again until No. 1 of the index now coincides with No. 4 of the main scale, it is possible to multiply 4 on the main scale by 2 on the index. (Fig. 4.) Therefore under No. 2 of the index should now be placed the product, or 8.

The index piece should be moved again until No. 1 of the index coincides with No. 8 of the main scale. (Fig. 5.) It is now possible to multiply 8 on the main scale by 2 on the index. Therefore under No. 2 of the index should be placed the product, or 16.

It is evident that the multiplying machine thus obtained can be used only for multiplying the numbers 1, 2, 4, and 8 by 2. Such a machine would be too limited for practical use. However, if the index piece is discarded, and there is substituted for it a new strip of wood or paper as long as the main scale, it is possible to transfer all the numbers of the main scale to the new strip. (Fig. 6.) The two scales, upper and lower, are identical.

By moving the upper scale (Fig. 7) until No. 1 of the upper scale coincides with No. 2 of the lower scale, it is possible to multiply with this setting of the rule, 2 by 2, 4 or 8. By moving the upper scale until No. 1 of the upper scale is made to coincide with No. 4 of the lower scale, it is possible to multiply 4 by 2 or 4. While this slide rule is somewhat better than that of Fig. 5, it still is practically useless because the numbers 3, 5, 6, 7, 9, and 10 are missing.

The question then arises as to the method of finding the exact positions of the numbers 3, 5, 6, 7, 9 and 10, which are missing. It is unnecessary to go higher than 10, and 16 will be dropped as soon as the position of 10 has been definitely fixed.

Fig. 8 shows the lower scale of the rule obtained in Fig. 5. The distances between the numbers 1, 2, 4, 8 and 16 are all equal to each other. The positions of the numbers 3, 5, 6, 7, 9 and 10 are still to be found.

Above the lower scale, and parallel with it are drawn horizontal lines, spaced equal distances apart, and marked 0, 1, 2, to 16, inclusive. Vertical lines are drawn from the lower scale at numbers 1, 2, 4, 8 and 16. The points at which the vertical lines of a certain number cross the horizontal lines of the same number, as for instance, where vertical line No. 4 crosses horizontal line No. 4, are marked by circles. Through the five circles thus located is drawn a smooth, continuous curve. It is evident that the curve thus drawn crosses all horizontal lines from 1 to 16, inclusive. It is very easy, therefore, to find the point at which

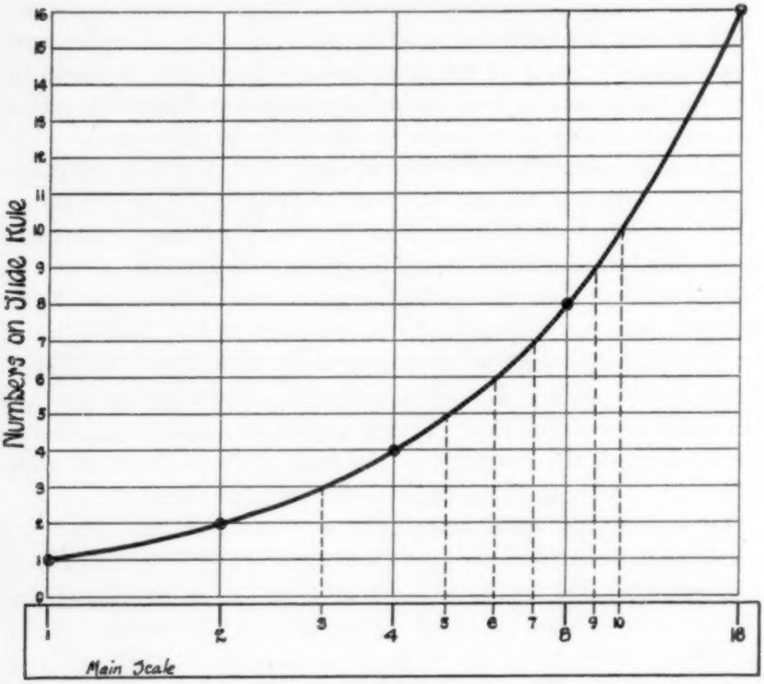


Fig. 8

the curve crosses horizontal line No. 3. Exactly below this point is the position for figure 3 on the main scale. Similarly, under the crossing point of the curve with horizontal line No. 5 is the precise position of figure 5 on the main scale. The positions of 6, 7, 9 and 10 are found in the same easy manner.

In order to construct the complete slide rule scale, it is also necessary to have the fractional divisions between numbers, such as 1.1, 1.2, 1.3, etc. All these numbers can be located in the same manner as the whole numbers, 3, 5, 6, etc. The scale may be subdivided as finely as desired by continuing the process of

finding the points on the curve, and dropping these points to the main scale below.

By performing the operations outlined in the above analysis, it is possible to construct a slide rule without the use of logarithms. The method is very simple, and is readily understood by students who do not possess mathematical training.

It is not to be construed that it is a feasible proposition to attempt to make a slide rule, except as a means of understanding its subdivision. Commercial slide rules are so well built, and they are equipped with so many useful scales in addition to the regular multiplication and division scales, that it would not pay to construct a rule, even if slide rules were doubled or tripled in price. The purpose of this article is merely to demonstrate a simple method of explaining the subdivision of the slide rule without resorting to conventional and difficult logarithmic analysis. Only those numbers and expressions are used which are familiar to the student untrained in mathematics.

SPOTS BEFORE THE EYES.

The prevalence of this condition has given rise to a great many curious ideas. Almost everyone either sees fixed or floating spots at times, or hears some friend complain of these conditions, so that it is not strange that many popular misconceptions have arisen. The commonest form of floating spots are those which are known by the name of muscae volitantes, an old name which indicates how long the condition has been observed. These are tiny transparent chains, or strings, which are seen especially on a white or brightly illuminated field. They persistently float in the line of vision, and though a shake of the head may carry them out of the way, they at once float back again. These spots are probably caused by the remains in the fluid part of the eye of certain cells which should have been completely absorbed in the development of the eye. They never lead to impairment of vision and, as before stated, are perfectly transparent. Other floating spots are due to cobweb-like masses of inflammatory material which are thrown out into the fluid of the eye by some low grade inflammation. These spots usually obscure the vision, which is their great point of difference from the former ones. It is, of course, very important to find out in any case whether the spots are due to inflammation, or not, and this can only be done by a skilled observer. It is a prevalent idea that the wearing of a dotted veil may leave permanent spots in the field of vision. While the dotted veil may be a source of strain by causing the wearer to pull on the eye muscles in order to avoid the obstruction of vision, it certainly is not the case that the dots, or any other object seen, can be permanently photographed on the nerve tissues of the eye. There is only one exception to this statement. Many people who have carelessly looked too much at the sun, generally in observing the eclipse, have actually produced a slight inflammatory change in the retina, so that there is always a blurry spot wherever they look. But it is doubtful if any light less brilliant than the sun can produce a permanent spot, and certainly a dark object can not do so.—Jour. Am. Medical Asso.

THE VALUE OF STANDARDS IN TEACHING ARITHMETIC.

By G. W. Finley,
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There are in general two main reasons for teaching arithmetic in the modern school: first, to make the children reasonably proficient in the fundamentals of number, and second, to give them training in the mathematical type of reasoning. Practically all teachers will agree that these two aims should always be kept in mind and that they must both be realized if efficient teaching is to be done. The teacher who fails in either is only half successful.

While both of these aims in teaching arithmetic, then, are important they are by no means equally easy of attainment. The first is by far the easier; so much so, in fact, that no teacher however lacking in special ability need fail here. This is not true of the training in reasoning. We cannot hope for satisfactory results in this kind of training until we have teachers specially prepared to do work along this line. But in spite of the fact that training in the fundamentals of number work is so simple a very little testing of children in the schools will convince any one, if indeed he is not already convinced, that even here teachers are failing to a lamentable degree. There are undoubtedly a good many contributory causes but I am convinced that chief among them all is lack of definite aims and standards on the part of teachers.

Ask almost any teacher how her children stand in the matter of speed and accuracy in arithmetic and she will answer that they are "fairly good" or "not very good," or give some other equally indefinite answer. Ask her if they are improving and she will answer still more indefinitely, "I believe so," or "I hope so." The trouble is she has no definite aim in view and no definite standards with which to compare her pupils, either as to present ability or as to progress made.

This is an unfortunate state of affairs, and an entirely unnecessary one. In the teaching of the fundamentals we can and should be as definite in our aims as are our colleagues in the business department in the teaching of typewriting. They work in no haphazard, hit or miss fashion. They have in mind at the beginning of the year just how many words a pupil should be able to write in a minute at the end of the year, and they work steadily and consistently to reach that standard. In the same

way every teacher of arithmetic should know just how many addition combinations her pupils should be able to write in a minute by the end of the year and should work steadily and persistently to reach that standard. So also with subtraction, multiplication, and division.

As to what the standards for the various grades should be we are fortunate in having at our command the results of the work done by such men as Rice, Stone, and Courtis. Mr. Courtis, after averaging tests from several thousand children, gives the following table:

STANDARD SCORES.

No. of Test.	No. 1	No. 2	Nos. 3 & 4	No. 5	No. 6		No. 7		No. 8	
					Ats.	Rt.	Ats.	Rt.	Ats.	Rt.
Grade 3	26	19	16	58	2.7	2.1	5.0	2.7	2.0	1.1
Grade 4	34	25	23	72	3.7	3.0	7.0	3.3	2.6	1.7
Grade 5	42	31	30	83	4.8	4.0	9.0	4.9	3.1	2.2
Grade 6	50	38	37	99	5.8	5.0	11.0	6.6	3.7	2.8
Grade 7	58	44	44	110	6.8	6.0	13.0	8.3	4.2	3.4
Grade 8	63	49	49	117	7.8	7.0	14.4	10.0	4.8	4.0
Grade 9	65	50	50	120	8.6	7.8	15.0	11.0	5.0	4.3

These tests covered the following ground:

Test No. 1. Addition.

Test No. 2. Subtraction.

Test No. 3. Multiplication.

Test No. 4. Division.

Combinations 0-9.

Test No. 5. Copying figures (rate of motor activity.)

Test No. 6. Speed reasoning (simple one-step problems showing number attempted and number right.)

Test No. 7. Fundamentals combined (abstract examples in the four fundamental operations.)

Test No. 8. Reasoning (two-step problems.)

These tests are exceedingly simple and can be given by any teacher without any special drill in this sort of work. To be of any use in determining standards they must be given to all the different grades, or to any one grade at different times, under exactly the same conditions. The exercises are printed or written on separate sheets of paper, one copy for each child, and placed face down on the desks of the children to be tested. At a given signal the children turn these sheets over and write as many answers as possible in the time allowed. Each sheet has more exercises on it than the swiftest child can complete in the time given.

Each of these tests consists of a sheet of exercises similar to the following:

Nos. 1 & 3.

```
4  6  9  5  8
1  2  7  3  6   etc.
—  —  —  —  —
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No. 2.

```
6  11  15  10  12
0   7   8   9   4   etc.
—   —   —   —   —
```

No. 4.

1)8 5)30 8)72 1)0 9)36 2)6 etc.

No. 5.

2 4 9 6 7 4 2 etc.

No. 6.

1. The children of a school gave a sleigh-ride party. There were 9 sleighs used and each sleigh held 30 children. How many children were in the party?
2. Two school girls played a number game. The score of the girl that lost was 57 points and she was beaten by 16 points. What was the score of the girl that won? etc.

(These problems are not to be solved. The children are to read them and write down the name of the operation to be used, addition, subtraction, multiplication, division.)

No. 7.

1. $6154 + 312 + 5800 + 4003 + 3020 + 265$.
2. $63210132 - 48676392$.
3. 46608×345.
4. $3128102 \div 453$, etc.

No. 8.

1. A party of children went from a school to a woods to gather nuts. The number found was but 205, so they bought 1955 nuts more from a farmer. The nuts were shared equally by the children and each received 45. How many children were there in the party? etc.

(Problems to be solved.)

The time allowances for these tests were as follows: Tests Nos. 1, 2, 3, 4, 5 and 6, one minute each; Test No. 7, twelve minutes; Test No. 8, six minutes. Complete copies of the original Courtis tests may be obtained from S. A. Courtis, Detroit, Mich.

The teacher who has before her some such definite standards as those set forth by Mr. Courtis and who finds out just where her pupils stand in the various abilities by applying such tests as those suggested here will then be in a position to do efficient work so far as training in the fundamentals is concerned. But so long as teachers have no standards with which to compare, and no definite aims toward which to work, so long shall we continue to hear that dismal refrain "Our public schools are a colossal failure," in so far, at least, as efficiency in the fundamentals of number work is concerned.

The thing of first importance, then, for any teacher or supervisor of arithmetic is to apply standard tests and find out what is needed. The next thing is to set to work deliberately and systematically to drill the pupils in the lines of work they need most. A fundamental principal here is, *To secure improvement in any specific line of work, drill in that line.* In other words if you want to get improvement in the addition combinations the surest and most economical way to get it is to drill on the addition combinations. Do not depend upon getting results indirectly. Drill exercises should of course be short, from three to five minutes, but they should be regular, daily if possible.

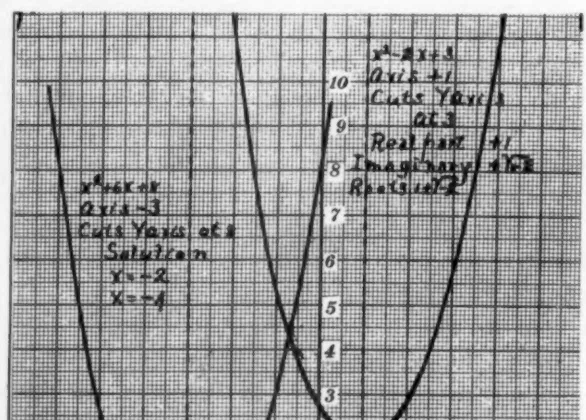
The results of such definite, systematic drill will be marked and immediate, both in improvement in the character of the work done and in the interest shown. Children like to do what they can do well and the teacher who sets up standards and helps her pupils to work toward them will be rewarded not only by seeing definite improvement in the work of the class, but by finding a new enthusiasm springing up in the children for work that they have been at least indifferent about before.

I have confined myself for the most part in this discussion to the teaching of fundamentals, not because it is the more important of the two reasons named in the outset for the teaching of arithmetic, but because it is the one most easily attained and the one in which the greatest amount of improvement may be made by the setting up of definite standards. No teacher is justified in working for this alone, but every teacher should bring her children to a reasonable degree of efficiency in the fundamentals whether she does anything else in her arithmetic teaching or not. If this can be done we will at least have delivered ourselves from the charge that we do not even teach the children to "cipher" correctly.

SOME GRAPHICAL METHODS.

By Robert C. Colwell,
Geneva College, Beaver Falls, Pa.

The general equation of the quadratic written in the form $y = x^2 + bx + c$ (1) represents the parabola $y = x^2$ moved to a certain position on the axes of reference. The position of the axis of the parabola is shown if equation (1) is written $y = \left(x + \frac{b}{2}\right)^2 - \frac{b^2}{4} + c$ (2). From analytics $-\frac{b}{2}$ is the abscissa of the axis of the parabola. Also, from (1) the parabola cuts the y-axis at the point $y = c$, that is, where $x = 0$. Any quadratic in form (1) is solved by moving the parabola $y = x^2$ as indicated. If the roots are real, the parabola cuts the x-axis in two points which give the required roots. If the roots are complex, the real part is given by the abscissa of the axis, and the square root of the ordinate of the vertex of the parabola (in this case measured downward and therefore negative) gives the imaginary part of the root. (See Fig. 1.)



Example I. Solve: $x^2 + 6x + 8 = 0$.

Let $y = x^2 + 6x + 8$.

One-half the coefficient of x with the sign changed is -3; hence the axis of the parabola lies along the line $x = -3$. When

$x=0$, $y=8$; therefore the curve cuts the y-axis where $y=8$. Move the parabola $y=x^2$ until its axis lies along the line $x=-3$ and the parabola itself cuts the y-axis at the point $y=8$; then read the solutions $x=-2$, $x=-4$. (See Fig. 1.)

Example II. Solve $x^2-2x+3=0$.

The axis of the parabola lies along the line $x=1$ and the parabola cuts the y-axis where $y=3$. When placed in this position, the parabola does not cut the x-axis; therefore the roots are complex. The real part is given by the abscissa of the axis of the parabola (in this case $+1$) and the imaginary part is found by taking the square root of the ordinate of the vertex of the parabola ($\pm\sqrt{-2}$). The complete roots are $+1\pm\sqrt{-2}$.

The formula for the solution of $x^2+bx+c=0$ is usually written $\dfrac{-b\pm\sqrt{b^2-4c}}{2}$ but it may be put in the form

$$-\frac{b}{2}\pm\sqrt{\frac{b^2}{4}-c}.$$

If we take a circle at the origin whose radius is $\sqrt{c}$ (see Fig. 2), lay off an abscissa $=-\dfrac{b}{2}$ and draw the ordinate PR, then from a well-known proposition in geometry

$$\overline{PR}^2=MR\cdot RC.$$

But
$$MR=\sqrt{c}+\frac{b}{2}$$

$$RC=\sqrt{c}-\frac{b}{2}$$

$$\therefore \quad PR=\sqrt{c-\frac{b^2}{4}}$$

$$\therefore \quad PR\sqrt{-1}=\sqrt{\frac{b^2}{4}-c}.$$

That is, the ordinate multiplied by $\sqrt{-1}$ represents the imaginary part of the root.

Again in the equilateral hyperbola,

$$x^2-y^2=c \quad (3),$$

when the abscissa is $-\dfrac{b}{2}$ the ordinate is $\sqrt{\dfrac{b^2}{4}-c}$. This comes at once from substitution in (3)

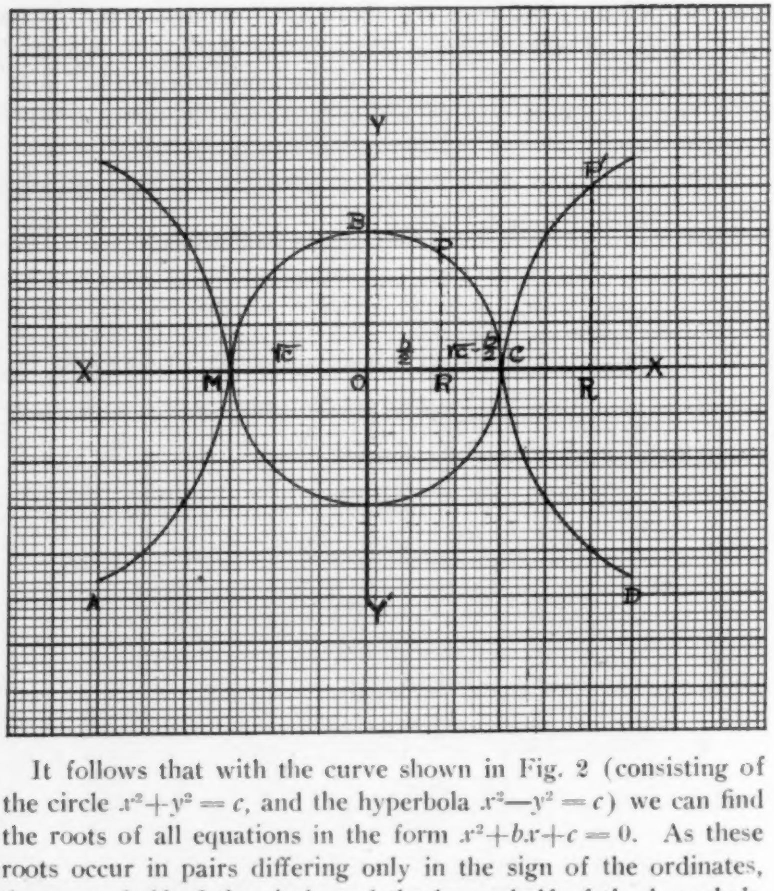
$$x^2-y^2=c,$$

$$\frac{b^2}{4}-y^2=c,$$

$$y^2 = \frac{b^2}{4} - c,$$

$$y = \pm\sqrt{\frac{b^2}{4} - c}.$$

In Fig. 2, if $OR' = \frac{b}{2}$, $P'R' = \sqrt{\frac{b^2}{4} - c}$.



It follows that with the curve shown in Fig. 2 (consisting of the circle $x^2 + y^2 = c$, and the hyperbola $x^2 - y^2 = c$) we can find the roots of all equations in the form $x^2 + bx + c = 0$. As these roots occur in pairs differing only in the sign of the ordinates, the upper half of the circle and the lower half of the hyperbola will give all the roots. Of course the branches MA and CD are infinite in length. In practical applications, the curve AMBCD changes when c is varied.

The parabola $y = x^2$ is useful for finding the roots, while the circle-hyperbola throws light on the relations of roots in the theory of quadratic equations. It should be noted that the circle-hyperbola curve can only be platted when c is positive.

HEIGHT OF CLOUDS AT SUNSET.

BY E. F. CHANDLER,
University of North Dakota, University, N. D.

The problem of the height of clouds above the earth's surface as determinable by the number of minutes after sunset that they may remain illuminated is an interesting question which may appropriately be considered in the prairie regions, but which seems not to have received much consideration previously in publications, because most scientific journals are published in or near mountainous regions where the question would not be so susceptible of reasonably accurate answer. The discussion of the problem on page 212 of the March issue of SCHOOL SCIENCE AND MATHEMATICS is a valuable contribution to the subject, but is unnecessarily complicated and for this reason may easily lead to error.

In this problem, altitudes of the clouds will be only a few miles, the greatest distance of the sun below the horizon cannot be more than three or four degrees, and (except in extreme latitudes) the time cannot exceed about a half-hour, so that several convenient approximations are proper.

Using the notation of the figures in the above-mentioned article,

$\lambda =$ latitude of observer.

$\delta =$ declination of sun.

$I =$ inclination of sun's path to vertical at point on horizon where sun sets.

$t =$ time from sunset to last illumination of cloud.

$\theta =$ angle of depression below horizon of sun at time of last illumination.

$h =$ height of cloud in miles.

Assuming the cloud to be in the zenith, we have from a right spherical triangle

$$(1) \qquad \sin I = \frac{\sin \lambda}{\cos \delta}$$

If the sun were on the equator, the length of the arc traversed by it during time t would equal t expressed in degrees. Otherwise the sun is traveling along the arc of a small circle, but as the length of the arc is only a few degrees its length is approximately equal to $t \cos \delta$.

The figure formed by this small-circle arc, the horizon, and the great circle passed vertically through the sun on which the angle θ is intercepted, is in this case nearly a right spherical triangle, so that approximately

$$\sin\theta = \sin(t\cos\delta)\cos l$$

which, as none of the sides are long, may be written without appreciable error

(2) $$\theta = t\cos\delta\cos l.$$

The radius of the earth being taken as 3960 miles,

$$\frac{(h+3960)^2-3960^2}{3960^2} = \tan^2\theta$$

from which, since h is negligible in comparison with 3960,

$$h = 1980\tan^2\theta$$

or more simply, if θ is expressed in degrees,

(3) $$h = 0.6(\theta)^2$$

If computation is made from the observation given in the article discussed, viz.:

June 8, 1914, $\delta = 22^\circ\ 49'$, $\lambda = 40^\circ\ 28'$, $t = 15$ min. $= 3^\circ\ 45'$, the computation is merely the use of formulas (1), (2) and (3), with these results:

$$l = 44^\circ\ 45',\quad \theta = 2^\circ\ 27',\quad h = 3.62 \text{ miles.}$$

The approximations here employed would not ordinarily affect appreciably the second decimal figure of the final result h. As the point where the sun's rays illuminating the cloud are tangent to the earth or the forests covering it is distant a hundred miles or more, its actual elevation as compared with the elevation of the observer is usually (except when the sun has set over the ocean's rim) in uncertainty much more than that amount, and refraction also introduces an uncertainty forbidding the use of more than two or three significant figures; therefore the above formulas are sufficiently precise.

The results thus computed would be correct for a cloud directly over the observer, or for clouds northward or southward of the observer along a line perpendicular to the azimuth of the sun from the observer, but not for clouds along a true north and south line except near the times of the equinox.

If the cloud is on the horizon between the observer and the sun, its height is *one-fourth* of the result given by the formula, not one-third as erroneously stated near the close of the article discussed.

This article is an excellent illustration of the danger of trusting to mathematical formulas without consideration of their suitability for computation. The formulas as stated in that article are theoretically correct, but lead to computations much longer than necessary in this case where the angles t and θ are small. Furthermore in this case some of the formulas are not permissible

for use because of the enormous errors in their use resulting from the neglected figures of trigonometric tables.

For example, formula (1), $h = 3960 \dfrac{1 - \cos\theta}{\cos\theta}$,

is mathematically correct, but if h was found according to it when θ was only one degree by the use of five-place trigonometric tables, an error amounting to as much as four per cent might enter the final result merely from the neglected decimals of the table. Whereas in a problem where the observations cannot be more precise than in this, computations ought to be so arranged that slide-rule work would give sufficiently satisfactory results, correct within one per cent.

It was undoubtedly the defect in this formula (1) which caused the error mentioned in the paragraph at the top of page 216, concerning height of cloud at horizon. The length of the process as outlined in the original article was perhaps the cause of the numerous other errors appearing there. On page 215, in formulas (4), $(z-\delta)$ and $(z+\delta)$ ought to be $(z-cA)$ and $(z+cA)$. At that place and time, really $\delta = 22° \ 51'+$, not $22° \ 49'$. $z = 86° \ 38'$ is absurd, its correct value being less than $64°$. θ is half a degree too small, and h is more than a mile too small.

HEALTH CONDITIONS IN THE NAVY.

According to the annual report of the Surgeon-General of the Navy, this branch of our national defense, from a medical point of view, is prepared to meet at least all peace-time demands. A summary of conditions during the year includes, among other important problems, the outbreak of small-pox on the *Ohio*, which was particularly noted by the lay press at the time. It will be remembered that there were twenty-nine cases of small-pox with five deaths. No cases occurred on the *Vermont*, although her men, examined and vaccinated just before sailing, were exposed in the same manner as those of the *Ohio*. An investigation showed, however, that no vaccination had been done on the *Ohio* for two years before the outbreak, and vaccination of the crew immediately after gave almost 90 per cent of takes, about what would be expected in an unprotected community. Among 100 recruits received on the *Ohio* shortly before sailing for Europe and vaccinated at that time, not a single case occurred. The report mentions also a slight increase in malaria, which is accounted for by the cases occurring on ships in Mexican waters. The Surgeon-General suggests that the white uniforms of the "bluejackets" be replaced by something of a more serviceable nature, for example, khaki or forestry green. He comments frequently on the need for a hospital ship to accompany each fleet, especially in relation to the operations at Vera Cruz, and the lessons to be gained by their study.—*Journal Am. Med. Assoc.*

A NEW DEVICE FOR MEASURING THE TIME BETWEEN COINCIDENCES.

BY OLIN L. WILLS.
Reed College, Portland, Oregon.

There are several methods for determining the period of a pendulum by comparison with a standard clock, all of which require the observer to make a judgement which is subject to personal error, it may be of the coincidence of a sound with the passing of a certain part of a body past the cross hairs of a telescope or it may be as to whether the image of a lighted Geissler tube makes a straight line after reflection from two mirrors one of which is stationary and the other is swinging in an arc with the pendulum.

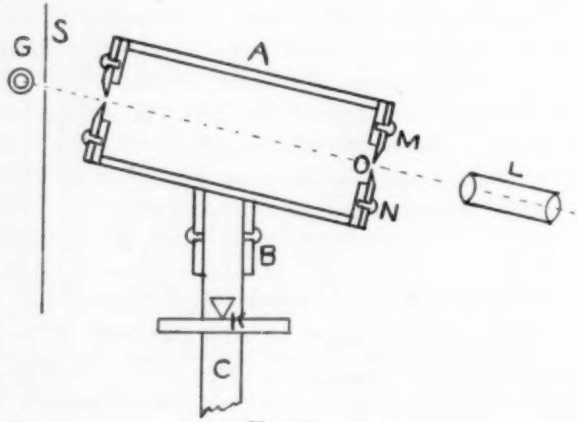


FIG. 1.

The apparatus here described simplifies the operation and gives very accurate results. The operation consists only in recognizing an instantaneous flash of light in which no judgement needs to be made, thus eliminating the personal reaction. The apparatus as illustrated in Fig. 1 was constructed for a Kater's pendulum *C* swinging from knife edges *K*. *A* is a tube on which two end plates are soldered. In these are holes of about half the diameter of the tube. Over these ends are two adjustable slides *M* and *N* with ground edges. The attaching socket *B* is inclined at an angle so that when the pendulum is reversed the telescope will not need to be placed so close to the floor. The whole apparatus is placed on one end of the pendulum. A Geissler tube *G* is placed behind a screen *S* in the rear of the apparatus and a tele-

scope L is focussed on the Giessler tube through the slit O. The Geissler tube is in circuit with a small induction coil whose primary coil is connected with a battery through the mercury contact of a standard clock. When the clock closes the circuit, that is, when its pendulum is at the lowest part of its swing, the tube flashes. If there is a coincidence, that is, if the pendulum

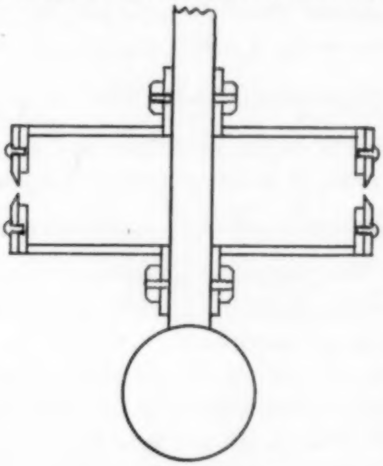


FIG. 2.

C is also at its lowest point, the observer can see the light through the telescope. Except at a coincidence no light can be seen. It is obvious that the longer the tube and the narrower the slits the more accurate are the results. A tube about ten centimeters long with slits about one millimeter wide should give good results.

Fig. 2 illustrates a similar piece of apparatus that has a more general application. It consists of two parts so that is can be clamped to any form of pendulum.

INDIANS MINED COPPER.

The copper product of Michigan is largely native and is considered for some purposes superior to "electrolytic" copper. "Lake" copper, as the product of Michigan is generally known in the trade, sells generally at about a quarter of a cent a pound above other coppers. The mining of copper in Michigan is of prehistoric origin, the metal having been used by the North American Indians before the advent of the white man. The development of copper mining, however, began in 1845, and since that date to the close of 1913 the production has amounted to over 5,335,000,000 pounds, or about 30 per cent of the total output of the United States.

A LECTURE EXPERIMENT WITH THE SIMPLE PENDULUM

By Thomas D. Cope,
University of Pennsylvania, Philadelphia, Pa.

The period of vibration of a pendulum, in the broadest sense in which the word is used, is determined by factors which may come from two sources viz: the structure of the pendulum itself, and the environment in which it is placed. For example, in the case of the magnetic pendulum, $T = 2\pi \sqrt{\frac{I}{MH}}$, the factors I and M are inherent in the pendulum and are independent of its environment, while H is determined by the environment alone. In the case of the simple gravitational pendulum, $T = 2\pi\sqrt{\frac{l}{g}}$, l depends upon the pendulum alone and would be the same whether the pendulum were on the earth or on the moon, while g is a factor of the environment only.

In a first course in Physics the simple gravitational pendulum is, as a rule, the only pendulum which the student learns to know. It has been the practice, so far as I have known it, to demonstrate by experiment that the period is independent of the mass of the bob, approximately independent of the amplitude of the swing, and directly proportional to the square root of the length. These factors are all of them inherent in the pendulum structure, and it seems desirable in this single case in which the beginner studies pendular motion to demonstrate to him in some striking way that environment also plays a part in determining the period.

To accomplish this end it occurred to me a few years ago to subject a simple pendulum to an influence similar to the one it would experience if its weight were suddenly increased while its mass remained constant. That is an attempt was made to show what would happen if g were increased. A ball of soft iron is hung from a fine wire, and underneath the equilibrium position of the ball is mounted an iron-core solenoid with its axis vertical, in circuit with storage cells, a rheostat, and a switch. The pendulum is set in vibration through a small arc while the circuit is open, and as soon as the class has grasped its period, the circuit is closed. The immediate decrease in period is so striking that no group of students has failed to see the point at once. When the circuit is again opened the pendulum returns to its former period.

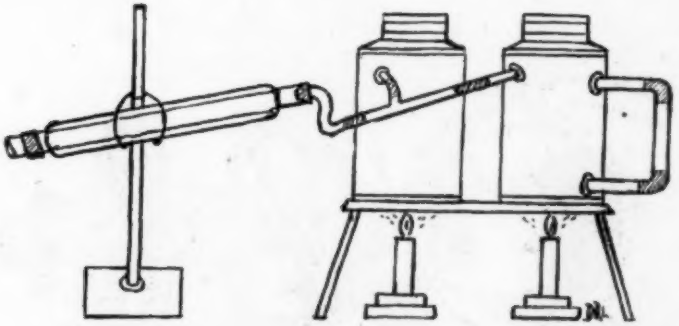
The factor g in the expression $T = 2\pi \sqrt{\frac{1}{g}}$ acquires a physical significance as well as a mathematical one.

My colleagues have done me the honor of adopting this experiment and in the hope that it may be of use in wider circles I take the liberty of submitting it to the public.

METHOD FOR DISTILLING WATER.

By H. K. Rhodes,
High School, Chambersburg, Pa.

All of our laboratories frequently have need of distilled water. Where no still or other especial apparatus is at hand, perhaps the following method may be suggestive and helpful.



Arrange two hypsometers or steam boilers side by side. At the exits where the mercury gauge is attached, connect by means of rubber tubing a Y-tube. Connect the third arm of the Y-tube to a Liebig or a worm condenser; then proceed as for ordinary distillation.

By this method I have been able to distill one liter of water in 30 to 40 minutes. No doubt three or four steam boilers could be arranged as described above thus giving better results.

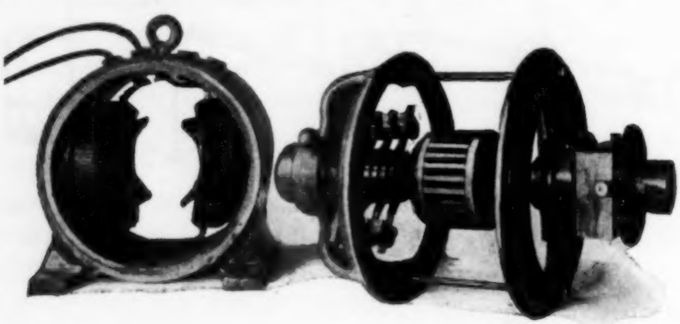
The production of chromic iron ore in the eastern portion of the United States, where the demand is greatest, ceased years ago. The supply is now obtained wholly by importation, mainly from South Africa. On the other hand, the Pacific coast supplies all its own demands by home production. Possibly with the completion of the Panama Canal the California product will also invade eastern markets.

A MODEL GENERATOR FOR THE PHYSICS LABORATORY.

By Henry Kempner,
Pratt Institute, Brooklyn, N. Y.

The model generator described in this article is used in the physics laboratory at Pratt Institute to familiarize the student with the principles of the electric generator; how it produces electrical energy, the nature of the E. M. F. produced and the construction of the machine.

The generator consists of the frame, field coils and drum armature of a standard Allis-Chalmers 2 H-P generator. On the armature are wound three coils easily distinguishable one from the other and each of which is brought out to a pair of collector rings. The collector rings and brushes are the standard parts of the generator. On the pulley end of the armature shaft, which projects about 3½" from the generator frame, is mounted a handle and ratchet arrangement by means of which the armature can be snapped around by hand 15 degrees at a time.



This generator is used in an experiment entitled, "Model generator: Instantaneous voltages induced in an armature," and following is a copy of the direction sheet covering the experiment taken from the students' laboratory manual.

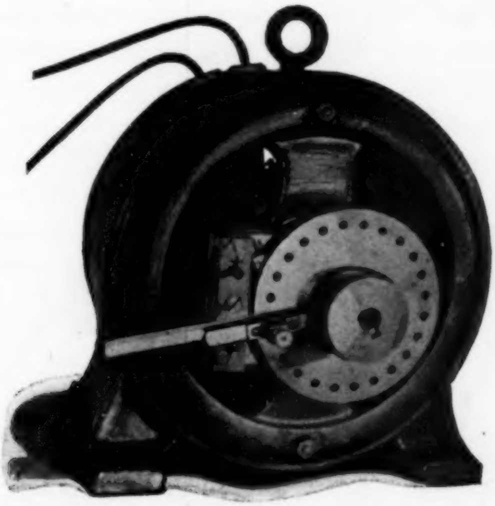
Model Generator: Instantaneous Voltages in an Armature.

Apparatus: Model generator, 1.5 — 150 volt D. C. Voltmeter, fuses, source of 110 volts pressure.

Method: Excite the fields of the generator. Connect the voltmeter to two brushes which are terminals of one of the armature coils. By means of the handle and ratchet snap the armature around 15 degrees and note the direction of the reading of the instrument. If it does not read in the proper direction reverse the voltmeter connections and repeat. Continue taking readings

until they fall to zero, then reverse the voltmeter connections and continue until you have taken a total of at least 24 readings. Care should be taken in snapping the armature around to move the handle at about the same rate for each reading.

It is advisable to try out the apparatus by taking a preliminary set of data in order that you may be sure just when to reverse the voltmeter connections.



From the direction of the field flux and direction of rotation of the armature determine by use of the right-hand rule the direction of the induced E. M. F. If the direction of the current through the field coils is reversed what would be the effect on the induced E. M. F.? Reverse your field connections and check.

Data and Results: Plot a curve of the induced E. M. F. On the X axis plot the angle of the armature coil with the vertical. On the Y axis plot the value of the voltage read paying due attention to sign.

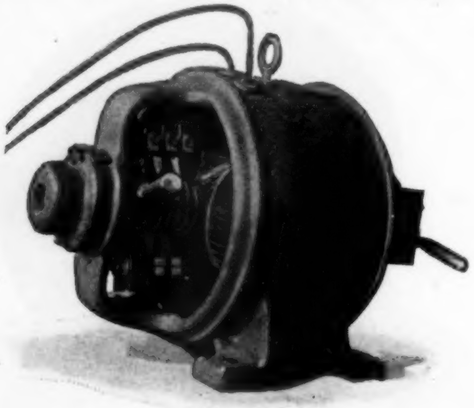
In red ink on the same paper plot the curve Y = Emax Sin X. Compare the two curves.

The experiment may be added to further by having the student remove the ratchet arrangement from the end of the armature shaft and connecting the armature to a motor. In this way the effect of the speed of the armature on the induced E. M. F., can be studied. By varying the strength of the field current and keeping the speed constant the effect of increased or decreased flux on the induced E. M. F. can be determined.

An interesting feature of the generator is the uniformity of

results obtained from it. The two curves of the induced E. M. F. shown represent the best and the worst results obtained by average students in a class of 35.

The machine has been in use for over a year during which period approximately 245 students have performed the experiment. During that time the only attention required by the apparatus has been the oiling of the shaft bearings. The machine having been originally built for commercial use should stand up easily under the use to which it is now being subjected for a long time.



This model generator has particular value to the student of the Pratt Institute type, who must get a considerable amount of theoretical and practical training in a short time, because it is a commercial piece of apparatus. It looks like the other generators the student sees around the laboratory and about the city. It is like those he will see when he gets out into actual commercial life. He is getting his theory from an actual piece of apparatus and consequently that theory becomes associated with a mental picture of the apparatus. He sees how the generator is built to conform to the laws governing an induced E. M. F. and also subconsciously absorbs standards of good commercial design and workmanship. The reasons for certain details in the design and construction of the generator are in this way made clear to the student and the one tending to recall the other will help him to remember both the theory and the construction.

A movement to introduce commercial apparatus into the laboratories appears to be developing and it should tend considerably toward lessening the impression that the school graduate is theoretical and not practical. Certainly such apparatus helps to make the laboratory exercises concrete problems.

PROBLEM DEPARTMENT.

By I. L. Winckler,

Central High School, Cleveland, Ohio.

Readers of this magazine are invited to propose problems and send solutions of problems in which they are interested. Problems and solutions will be credited to their authors. Address all communications to I. L. Winckler, 32 Wymore Ave., E. Cleveland, Ohio.

Algebra.

421. *Proposed by Norman Anning, Clayburn, B. C.*

A carpenter's rough rule for octagon miter is: "Twenty-four and ten, cut on the ten."

(a) What other pair of integers on the steel square (barring 12 and 5) give as good an approximation?

(b) What is the best pair of numbers on an ordinary steel square graduated to eighths of an inch?

I. *Solution by the Proposer.*

One-half the angle of a regular octagon is $67\frac{1}{2}°$.

$$\tan 67\tfrac{1}{2}° = 1+\sqrt{2} = 2+\frac{1}{2+}\,\frac{1}{2+}\,\frac{1}{2+}\quad . \; . \; .$$

Approximations to the true value, 2.4142135 . . . are found in the convergents to the continued fraction. These are:

$$\frac{2}{1}\;{}^{2}\;\frac{5}{2}\;{}^{2}\;\frac{12}{5}\;{}^{2}\;\frac{29}{12}\;{}^{2}\;\frac{70}{29}\;{}^{2}\;\frac{169}{70}\;{}^{2}\;\frac{408}{169},\text{ etc.}$$

Inserting intermediate convergents by using partial quotient 1 instead of 2, we have the rising series:

$$\frac{2}{1},\;\frac{7}{3},\;\frac{12}{5},\;\frac{41}{17},\;\frac{70}{29},\;\frac{239}{99},\quad . \; . \; .$$

and the falling series:

$$\frac{5}{2},\;\frac{17}{7},\;\frac{29}{12},\;\frac{99}{41},\;\frac{169}{70},\quad . \; . \; .$$

Of these, $^{17}/_{7}$ has the largest numerator less than 24, and $^{169}/_{70}$ has the largest numerator less than 8×24.

(a) "seventeen and seven" answers question *a* since

$$^{17}/_{7}-(1+\sqrt{2}) = .01436,$$

while $$(1+\sqrt{2})-^{24}/_{10} = .01421,$$

The amount of difference in each case being nearly one part in seventy.

(b) "$21\frac{1}{8}$ and $8\frac{3}{4}$" is very nearly the true value since

$$\frac{17}{7}-\frac{169}{70}=\frac{169}{70}-\frac{24}{10}=\frac{1}{70}.$$

Geometry.

422. *Proposed by Henry B. Sanders, New York, N. Y.*

ABC is a triangle, right-angled at C. Angle B is bisected by BD, which meets AC at D.

Prove that $2\overline{BC}^2 : \overline{BC}^2-\overline{CD}^2 = CA : CD$.

I. *Solution by Niel Beardsley, Bloomington, Ill., and Nelson L. Roray, Metuchen, New Jersey.*

$$\frac{CD}{DA}=\frac{BC}{BA}=\frac{BC}{\sqrt{\overline{BC}^2+\overline{AC}^2}}=\frac{CD}{AC-CD}.$$

$$\therefore \quad \frac{\overline{BC}^2}{\overline{AC}^2+\overline{BC}^2}=\frac{\overline{CD}^2}{\overline{AC}^2+\overline{CD}^2-2AC\times CD}.$$

Clearing of fractions and simplifying

$$\overline{CD}^2\times AC=\overline{BC}^2\times AC-2\overline{BC}^2\times CD.$$

$$2\overline{BC}^2\times CD=\overline{BC}^2\times AC-AC\times\overline{CD}^2.$$

$$\therefore \quad \frac{2\overline{BC}^2}{\overline{BC}^2-\overline{CD}^2}=\frac{AC}{CD}.$$

II. *Solution by Norman Anning, Clayburn, B. C.*

$$\tan B=\frac{2\tan\frac{1}{2}B}{1-\tan^2\frac{1}{2}B}.$$

$$\frac{BC\tan B}{BC\tan\frac{1}{2}B}=\frac{\overline{BC}^2}{\overline{BC}^2}\cdot\frac{2}{1-\tan^2\frac{1}{2}B}$$

$$\frac{AC}{CD}=\frac{2\overline{BC}^2}{\overline{BC}^2-\overline{CD}^2}.$$

423. *Proposed by Norman Anning, Clayburn, B. C.*

Lines through the vertices of a triangle ABC divide the opposite sides in the ratios $m:n$, $p:q$, $r:s$. If XYZ is the triangle they determine, show that

$$\frac{\Delta XYZ}{\Delta ABC}=\frac{(mpr-nqs)^2}{(mq+nq+mp)(ps+qs+rp)(rn+sn+mr)}.$$

(NOTE.—The third term in the first factor of the denominator as proposed was nm. It should have been mp.)

I. *Solution by the Proposer.*

BC is divided in the ratio $m:n$.

CA is divided in the ratio $p:q$.

AB is divided in the ratio $r:s$.

Point X is on the lines through B and C, etc. Join AX.

$$\frac{\Delta ABC}{\Delta BXC}=\frac{\Delta BXC+\Delta CXA+\Delta AXB}{\Delta BXC}=1+\frac{r}{s}+\frac{q}{p}.$$

$$\frac{\Delta BXC}{\Delta ABC}=\frac{1}{1+\frac{r}{s}+\frac{q}{p}}.$$

$$\frac{\Delta CYA}{\Delta ABC}=\frac{1}{1+\frac{m}{n}+\frac{s}{r}}.$$

$$\frac{\Delta AZB}{\Delta ABC}=\frac{1}{1+\frac{p}{q}+\frac{n}{m}}.$$

$$\Delta XYZ=\Delta ABC-\Delta BXC-\Delta CYA-AZB.$$

$$\frac{\Delta XYZ}{\Delta ABC}=1-\frac{1}{1+\frac{r}{s}+\frac{q}{p}}-\frac{1}{1+\frac{m}{n}+\frac{s}{r}}-\frac{1}{1+\frac{p}{q}+\frac{n}{m}}$$

$$=\frac{(mpr-nqs)^2}{(mq+nq+pm)(ps+qs+rp)(rn+sn+mr)}.$$

Ceva's theorem is a consequence.

II. *Solution by Nelson L. Roray, Metuchen, N. J.*

Let AA_1 cut BC into sects whose ratio is $m:n$.

Let BB_1 cut AC into sects whose ratio is $p:q$.
Let CC_1 cut AB into sects whose ratio is $r:s$.
Let AA_1 cut BB_1 and CC_1 at X and Z respectively.
Let BB_1 cut CC_1 at Y.

Then $\dfrac{\Delta CYB}{\Delta CC_1B}=\dfrac{CY}{CC_1}$ and $\dfrac{\Delta CC_1B}{\Delta ABC}=\dfrac{s}{s+r}\therefore\dfrac{\Delta CYB}{\Delta ABC}=\dfrac{CY}{CC_1}\cdot\dfrac{s}{s+r}$.

Take AC as transversal of ΔC_1YB

then
$$\frac{r}{r+s}\cdot\frac{CY}{CC_1}\cdot\frac{BB_1}{YB_1}=1.$$

Also CC_1 as transversal of ΔABB_1

then
$$\frac{BY}{YB_1}=\frac{ps+qs}{pr}.$$

$$\therefore\quad \frac{YB_1}{BB_1}=\frac{pr}{ps+qs+pr}$$

or
$$\frac{CY}{CC_1}=\frac{p(r+s)}{ps+qs+pr}.$$

$$\therefore\quad \frac{\Delta CYB}{\Delta ABC}=\frac{ps}{ps+qs+pr}.$$

Similarly
$$\frac{\Delta AZC}{\Delta ABC}=\frac{nr}{nr+ns+mr}.$$

$$\frac{\Delta AXB}{\Delta ABC}=\frac{mq}{mq+nq+mp}.$$

$$\therefore\ \frac{\Delta CYB+\Delta AZC+\Delta AXB}{\Delta ABC}=\frac{ps}{ps+qs+pr}+\frac{nr}{nr+ns+mr}+\frac{mq}{mq+nq+mp}.$$

Add, take the proportion by division and we get

$$\frac{\Delta XYZ}{\Delta ABC}=\frac{(mpr-nqs)^2}{(ps+qs+pr)(nr+ns+mr)(mq+nq+mp)}.$$

Note 1.—If $mpr-nqs=0$ then $\Delta XYZ=0$ and BB_1, CC_1, and AA_1 are concurrent, that is $\dfrac{mpr}{nqs}=1$. Ceva's Theorem.

Note 2.—If $m=n$, $p=q$, $r=s$, we have the condition for medians, and $mpr-nqs=0$.

Note 3.—If $\dfrac{m}{n}=\dfrac{r+s}{p+q}$ etc., it is easily shown that $mpr-nqs=0$, that is, the bisectors of the angles are concurrent.

Note 4.—It is easily proved that for the altitudes $mpr-nqs=0$.

424. *Proposed by Elmer Schuyler, Brooklyn, N. Y.*

Given the edge of a regular tetrahedron equal to a, to find the radius of the sphere that touches the six edges.

I. *Solution by the Proposer.*

The diameter is the altitude of an isosceles triangle having for equal sides the altitudes of two of the faces, i. e., equal sides equal to $\dfrac{a}{2}\sqrt{3}$.

The base of this isosceles triangle is a.

Hence radius $=\frac{1}{2}$ diameter $=\frac{1}{2}\cdot\dfrac{a}{2}\sqrt{2}=\dfrac{a}{4}\sqrt{2}$.

II. *Solution by Carrie Mikesell, Greenville, Ohio.*

Let $ABCD=$ a regular tetrahedron whose edge is a.

Let $x=$ slant height AE.

Let $z = \perp$ dropped from vertex A to O′, point of intersection of medians of base BCD.

Let $r =$ radius of sphere drawn from O, center of sphere, to point where sphere touches edge AD at F, bisecting AD and $\perp$ to it at F.

ΔAED = rtΔ, ED = ½CD = $\frac{1}{2}a$.

$$\therefore\ x = \sqrt{a^2 - \frac{a^2}{4}} = \frac{a\sqrt{3}}{2}$$

Since the medians of a Δ meet in a point ⅔ of distance from each vertex to middle of opposite side,

$$O'E = \tfrac{1}{3}BE = \tfrac{1}{3}x = \frac{a\sqrt{3}}{6}$$

ΔAO′E = rtΔ.

$$\therefore\ z = \sqrt{\frac{3a^2}{4} - \frac{3a^2}{36}} = \frac{2a}{\sqrt{6}}.$$

Since the lines drawn from each vertex of a tetrahedron to the point of intersection of medians of opposite faces all meet in a point called the center of gravity, which divides each line so that the shorter segment is to whole line in ratio 1 : 4, then, O, center of sphere, lies on z, ¾ of distance from A to O′.

$$\Delta AOF = \text{rt}\Delta,\ AF = \frac{a}{2},\ AO = \frac{3}{4}\cdot\frac{2a}{\sqrt{6}} = \frac{3a}{2\sqrt{6}}$$

$$\therefore\ r = \sqrt{\frac{9a^2}{24} - \frac{a^2}{4}} = \frac{a}{2\sqrt{2}},\ \text{radius of required sphere.}$$

III. *Solution by Thomas J. Leslie, University, Alabama.*

The section of the sphere made by a face of the tetrahedron is a circle inscribed in the triangle forming the face. This circle must be tangent to the edge of the tetrahedron at the same point the sphere is tangent to the edge. Therefore the sphere is tangent to an edge at its mid-point. The center of the sphere lies in the altitude of the figure since it is regular. Now the triangle formed by one edge, altitude and ⅔ of median of face of the tetrahedron, and the triangle formed by ½ side, radius of sphere, and portion of altitude above center of sphere are similar (having two angles equal).

$$\tfrac{2}{3}\text{ of median of face} = \tfrac{2}{3}\text{ of } \frac{a}{2}\sqrt{3} = \frac{a}{3}\sqrt{3}.$$

$$\text{Altitude of tetrahedron} = \sqrt{a^2 - \frac{a^2}{3}} = \sqrt{\tfrac{2}{3}a^2} = \frac{a}{3}\sqrt{6}.$$

From similar triangles above mentioned,

$$\tfrac{1}{2}a : r = \frac{a}{3}\sqrt{6} : \frac{a}{3}\sqrt{3}.$$

$$\text{From this } r = \frac{a\sqrt{2}}{4}.$$

Trigonometry.

425. *Proposed by Orlo Stearns, Washington, D. C.*

If $\sin 2x = \sin^2 3x$ show that $x = 15°$.

(From Gore's *Plane and Spherical Trigonometry.*)

I. *Solution by Norman Anning, Clayburn, B. C.*

$$\sin 6x = 3\sin 2x - 4\sin^3 2x$$
$$= 3\sin^2 3x - 4\sin^6 3x.$$
$$2\sin 3x\cos 3x = 3\sin^2 3x - 4\sin^6 3x.$$

Then either $\sin 3x = 0$, and $x = 0$,

or $2\cos 3x = 3\sin 3x - 4\sin^3 3x$.

$4(1-\sin^2 3x) = 4\cos^2 3x = 9\sin^2 3x - 24\sin^4 3x + 16\sin^{10} 3x$.

$16\sin^{10} 3x - 24\sin^4 3x + 13\sin^2 3x - 4 = 0$.

Put $z = 2\sin^2 3x = 2\sin 2x$.

$z^5 - 6z^3 + 13z - 8 = 0$.

$(z-1)^2(z^3+2z^2-3z-8) = 0$.

The cubic has one real root, 1.87513.

$2\sin 2x = 1$ or 1.87513.

$\sin 2x = \frac{1}{2}$ or $.93756$.

$$x = \left\{ \begin{matrix} 15^\circ, & 34^\circ\, 49\frac{1}{3}', & 0^\circ \\ 75^\circ, & 55^\circ\, 10\frac{2}{3}', & \end{matrix} \right\}$$

Further solutions may be obtained by increasing any of these by any integral multiple of 180°.

II. *Solution by J. J. Ginsberg, Brooklyn, New York, and L. E. A. Ling, La Grange, Ill.*

$$1-\sin 2x = 1-\sin^3 3x.$$
$$\cos^2 x + \sin^2 x - 2\sin x\cos x = \cos^2 3x.$$
$$(\cos x - \sin x)^2 = \cos^2 3x.$$
$$\cos x - \sin x = \cos 3x.$$
$$\cos x - \cos 3x = \sin x.$$
$$2\sin 2x\sin x = \sin x.$$

$\therefore\ \sin x = 0$, and $2\sin 2x = 1$.

$\therefore\ x = 0$, and $2x = 30^\circ$, or $x = 15^\circ$.

[Correction.—Solution I of Problem 413 in the March issue was incorrect. The proportion DO : OB = OX : OY does not prove the triangles DOY and XOB similar.—Editor.]

CREDIT FOR SOLUTIONS.

417. William Feuerwerger. (1)

421. Norman Anning. (1)

422. Norman Anning (2), W. L. Baughman, Niel Beardsley, Paul C. Bickel (2), William Feuerwerger, Martha I. Ivins, Thomas J. Leslie, H. C. McMillin, Nelson L. Roray, Beulah I. Shoesmith, James H. Weaver, George W. Wriston. (14)

423. Norman Anning, Nelson L. Roray, James H. Weaver. (3)

424. Norman Anning, W. E. Dennison, Walter C. Eells, J. J. Ginsberg, "Hoxie," Berea, Ky., Thomas J. Leslie, H. C. McMillin, Carrie Mikesell, R. H. Montgomery, Nelson L. Roray, Elmer Schuyler, one incorrect solution. (12)

425. Norman Anning, Niel Beardsley, Paul C. Bickel, Robert C. Colwell, J. J. Ginsberg, Thomas J. Leslie, L. E. A. Ling, H. C. McMillin, F. N. Nolestein, Nelson L. Roray, Elmer Schuyler, James H. Weaver, Edward H. Worthington. (13)

Total number of solutions, 44.

PROBLEMS FOR SOLUTION.

Algebra.

431. *Proposed by J. J. Ginsberg, Brooklyn, N. Y.*

Factor: $x^{10}+x^5+1$.

Geometry.

432. *Proposed by H. E. Trefethen, Waterville, Maine.*

Two unequal circles intersect in A and B. A straight line is drawn through A meeting the circles again in P and Q, respectively.

Find the position of PAQ (a) when $PA+AQ$ is greatest, (b) when $PA \cdot AQ$ is greatest.

433. *Proposed by H. E. Trefethen, Waterville, Maine.*

If D is the diameter of a circle, and d the distance between its centre and the intersection of perpendicular chords m and n, prove that $m^2+n^2=2D^2-4d^2$.

434. *Proposed by H. C. McMillin, Kingman, Kansas.*

If perpendiculars are drawn from the orthocenter of the triangle ABC on the internal and external bisectors of the angle C, prove that their feet are collinear with the mid-point of AB.

435. *Proposed by Nelson L. Roray, Metuchen, N. J.*

A curve on a railway, whose form is a circular quadrant, has telegraph posts at its extremities and at equal distances along the arc, the number of posts being n. A person in one of the extreme radii produced sees the pth and qth posts from the extremity nearest him (from which his distance is a) in a straight line. Find the radius of the curve.

TEACHERS' ASSOCIATIONS.

One of the most valuable means by which teachers of all grades, from the kindergartener to the University research man, have for increasing their knowledge in their own line of work, is the attendance upon Association meetings. This fact is not appreciated by a great many of our secondary school teachers, as but a small percentage of instructors engaged in this work ever attend these meetings. The inspiration which one secures in exchanging views with people engaged in the same kind of work, is of a value which cannot be expressed in dollars and cents. It is something which puts new and vital energy into everyone who enters into the spirit of the meeting. It broadens one's acquaintanceship, brings him into touch with people who may be teaching the same line of work as himself, and yet who, from force of circumstances existing in the locality in which they are working, are obliged to present their subjects in a manner entirely different from that of anyone else. This gives the teacher a new point of view, with many new and live features which he could wisely incorporate into his own work and methods of teaching.

The next best thing to attendance upon the meetings is to become a member in one or two live Associations, in order to secure the literature and the reports of the meetings which are issued from time to time. Then too, membership in many Associations secures with it, if the dues are promptly paid, a subscription to some valuable journal at a reduced rate, in whose pages matters of interest to every teacher are discussed. This not only will be helpful to the individual, but at the same time it will assist the Association in furthering its work among its membership. There is no progressive teacher who can afford not to become affiliated with some one or two or more live Associations. It has been the observation of the writer during a long period that those teachers who are not members of an Association or who are not subscribers to several progressive journals, have either gone to seed or are rapidly approaching that condition. In some of these cases, of course, there is no hope for these individuals, but with others, an awakening to their condition will be sufficient to make out of them progressive teachers.

SCIENCE QUESTIONS.

By Franklin T. Jones,
University School, Cleveland, Ohio.

Readers of School Science and Mathematics *are invited to propose questions for solution—scientific or pedagogical—and to answer questions proposed by others or by themselves. Kindly address all communications to Franklin T. Jones, University School, Cleveland, Ohio.*

Questions and Problems for Solution.

Please answer questions numbered 182, 183, 184, 185, *in the following lists:*

Cornell University Department of Chemistry.
Introductory Inorganic Chemistry Final Examination, June 7, 1912.

1. Define and illustrate the use of the following terms: (a) Catalytic Agent, (b) Polymer, (c) Dibasic Acid, (d) Secondary Salt, (e) Fractional Distillation, (f) Reversible Reaction, (g) Valence, (h) Hydrolysis, (i) Water of Crystallization, (j) Element.

182. What volume of gas, measured under standard conditions, would be liberated respectively by the action of

(a) Hydrochloric acid in excess upon 100 grams of calcium carbonate?
(b) Sulphuric acid in excess upon 65 grams of zinc?
(c) Water in excess upon 128 grams of calcium carbide?
(d) Hydrochloric acid in excess upon 88 grams of ferrous sulphide?

3. Complete and balance each of the following equations:

(a) $CaCO_3$ (heated) =
(b) $AgNO_3+KCl$ =
(c) $CaCO_3+H_2O+CO_2$ =
(d) $H_2C_2O_4+H_2SO_4$ (conc.) =
(e) $P+KOH+H_2O$ (heated) =
(f) H_2S+SO_2 =
(g) $Cl+KI$ =
(h) $H_2S+Pb(NO_3)_2$ =
(i) $C_2H_2+O_2$ (ignited) =
(j) $C_2H_4+O_2$ (ignited) =

4. Write the names of each of the following compounds, and group the substances into three classes, according as they are (a) acids, (b) bases, (c) salts:

$Ca(OCl)_2$, $Al(OH)_3$, H_3AsO_3, HBr, $NaHSO_4$, $KClO_3$, Na_2CO_3, H_3PO_4, $BaSO_4$, NH_4OH.

5. (a) How may hydrogen chloride be prepared? Give equation. What are its properties?

183. (b) What volume of a solution of hydrochloric acid containing 73 grams of HCl per liter will be required for the complete neutralization of a solution of sodium hydroxide obtained by bringing 23 grams of metallic sodium into contact with water?

6. Describe two methods for the preparation of oxygen, and two methods for the preparation of hydrogen. Give equations.

7. Describe as fully as you can a commercial method for the manufacture of sulphuric acid, writing equations to express the reactions involved. Name two important practical uses of sulphuric acid.

8. What is thermit? Describe the Goldschmidt process for welding steel rails. Write an equation expressing the chemical reaction involved.

9. (a) State the Periodic Law. Of what use is this generalization to the chemist?

(b) State Avogadro's Hypothesis. How would you make use of this hypothesis in calculating, for example, the volume of oxygen necessary to effect the complete combustion of 10 liters of carbon monoxide?

10. (a) What are the constituents of ordinary mortar? Write an equation expressing the chemical reaction involved in the drying of mortar.

(b) Describe briefly the "mechanical" filtration process for the purification of water for municipal use. What part is played by the aluminum sulphate?

UNIVERSITY OF THE STATE OF NEW YORK.

Physics, September 16, 1913—9:15 a. m. to 12:15 p. m. only.

Answer 10 questions, selecting at least three questions from Group I and at least one from each of the other groups. Each complete answer will receive 10 credits.

Group I.

Answer at least three questions from this group.

1. Define or explain *five* of the following: mass, weight, density, inertia, moment of a force, capillary action, conservation of energy.

2. Three forces act on a point as follows: 10 units from the north 12 units from the east and 16 units from the southeast; find the magnitude and indicate by a diagram the direction of a force that would hold the three given forces in equilibrium.

184. The pressure in a city water main is 40 lb. per square inch. The diameter of the plunger of a hydraulic elevator is 12 inches. Loss by friction is 33⅓ per cent. How heavy a load can the elevator lift?

4. Describe carefully *two* methods of finding the specific gravity of liquids.

185. If the specific gravity of ice is .92 and the specific gravity of sea water is 1.027, what is the greatest weight that a cubic yard of ice floating in sea water will support?

6. Describe the essential parts and explain the operation of a non-condensing air pump. Why can not a perfect vacuum be produced by means of the air pump?

Group II.

Answer at least one question from this group.

7. Define conduction of heat, radiation of heat and convection of heat. Show how each is illustrated in heating a room with hot water in a radiator.

8. Find the number of heat units required to convert 500 grams of water at 5° C. into steam at 130° C. [Latent heat of steam = 537; specific heat of steam = .5.]

Group III.

Answer at least one question from this group.

9. What relation between the length of pipe and its wave length gives the most nearly perfect resonance in (a) an open pipe, (b) a closed pipe? Explain by aid of diagrams your answers to (a) and (b).

10. Distinguish between harmony and discord in music and explain the production of beats.

11. Explain by aid of diagrams the formation of a primary rainbow.

Group IV.

Answer at least one question from this group.

12. Name and define the unit of current strength. Describe an efficient method of determining the current strength of a given electric circuit.

13. Show by a labeled diagram the construction of an electro-magnet. Indicate the direction of the current in the magnet.

14. An electric current is divided among three parallel wires having resistances 3, 12 and 18 ohms respectively; find the combined resistances of the three parallel wires.

Solutions and Answers.

160. *Proposed by H. C. McMillin, Kingman, Kans.*

Compare the times of descent of a hollow and a solid sphere rolling down an inclined plane.

[*Another solution has come to hand which brings out the facts that "all solid spheres roll down a given rough plane (if there is no slipping) with equal accelerations, no matter what their masses or their radii. Hollow spheres, whatever their masses or their radii, roll down the same rough plane with smaller accelerations."*

The contributor adds—"I can not refrain from adding that I trust no one has thought of including this problem in a school science program. In such a one it would be, according to my opinion, distinctly out of place.]

Solved by E. A. Eckhardt, University of Pennsylvania, Philadelphia, Pa.

161, 162, 163, 164. *Also solved by P. K. Shah and C. M. Jhaveri, Boys' High School, Sojitra, India.*

168. *Proposed by W. L. Baughman, East St. Louis, Ill.*

A particle P is at rest at a point A on the uppermost point of a smooth vertical circle ABC. If the particle slides from rest, at what point in its path will it leave the circle?

Solution by Niel Beardsley, Bloomington, Ill.

The value of the velocity of a body sliding on a smooth vertical circle is $v^2 = 2gh$ where h is the distance of descent measured vertically.

To apply this to the given problem let A be at the vertex of the circle and P the desired point. Where the object leaves the circle the centrifugal force must just equal the pressure of the particle against the circle.

$$\frac{wv^2}{r} = wg\cos\theta \qquad v^2 = 2gh$$

$$\cos\theta = \frac{r-h}{r}$$

$$\frac{w(2gh)}{r} = wg\left(\frac{r-h}{r}\right)$$

$$3h = r.$$

$\therefore$ The particle will leave at a point where it has descended $\frac{1}{3}$ of the radius.

Also solved by W. L. Baughman (who expresses his solution in terms of the angle from the vertical). Answer 48.19°, or $\cos x = \frac{2}{3}$.

169. *From a Princeton Examination.*

An eight-oared crew makes 35 strokes per minute. The pull in each stroke is for a distance of 5 feet, and the average pull per man during each stroke is 70 lbs. Calculate the horse-power of the crew.

Solution by A. Haven Smith, Riverside, Cal.

$70 \times 5 = 350$ ft. lbs. Work per stroke per man.
$350 \times 35 = 12{,}250$ ft. lbs. Work per minute per man.
$12{,}250 \times 8 = 98{,}000$ ft. lbs. Total work.
$98{,}000 \div 33{,}000 = 2.97$ H. P.

170. Electric energy costs 8 cents per K.-w. hour. A 110 volt motor takes 2 amperes. How much will it cost to run the motor for 30 days, 10 hours per day?

Solution by A. H. Smith.

$110\times 2 = 220$ Watts.

$220\times 30\times 10 = 66{,}000$ Watt-hours.

$66{,}000\div 1{,}000 = 66$ K.-w. hr.

$66\times .08 = \$5.28$.

172. *Proposed by Maxwell Sosin, Perth, Amboy, N. J.*

What is the edge of a cube of marble (s. g. $=2.7$) that can yield just enough CO_2 to produce 2889 grams of Na_2CO_3 by the Solvay Process?

Solution by Harry D. Jackson, Alma College, '15, Alma, Mich.

Marble is calcium carbonate ($CaCO_3$).

$CaCO_3 = CaO + CO_2$.

Solvay Process:

$NaCl + NH_3 + CO_2 = NaHCO_3 + NH_4Cl$.

$2NaHCO_3 = Na_2CO_3 + CO_2 + H_2O$.

$Na_2CO_3 : 2889 = CO_2 : x$.

$106 : 2889 = 44 : x$.

$\therefore\ x = 1{,}999.20755$.

$2x = 2{,}398.415 =$ No. of g. of CO_2 required.

$CaCO_3 = CaO + CO_2$.

$100.09 : x = 44 : 2398.415$.

$x = 5455.849 =$ No. of g. of marble in cube.

$$\frac{5455.849}{2.7} = 2020.68 = \text{No. of c.c. of marble.}$$

$\sqrt[3]{2020.68491} = 12.5+$ cm. $=$ length of edge of marble cube.

Also solved by R. W. Boreman, Parkersburg, W. Va., and Claude Scuder, Sumner, Ill.

Mr. Boreman assumes all the CO_2 to be used and finds a volume 1009.5 c. c. of $CaCO_3$.

Solution by Claude Scuder.

Na_2CO_3 is 41.5 per cent CO_2. Therefore 41.5 per cent of 2889 gm. or 1198.9 gm. of CO_2 is required. In the Solvay Process an equal amount to that used in the final product is liberated, so twice 1198.9 or 2397.8 gm. of CO_2 is required for the complete process. $CaCO_3$ is 44 per cent CO_2. Therefore 44 per cent of the number of gm. of $CaCO_3$ used $= 2397.8$ gm., and 100 per cent of the $CaCO_3$ used $= 5449$ gm. Dividing this by 2.7, the density of marble, we obtain the volume, 2018 c. c. One edge then equals $\sqrt[3]{2018} = 12.5+$ cm.

AN ENTERPRISING FIRM.

Ginn and Company of Boston, Massachusetts, have surely shown considerable enterprise and progressiveness in preparing for the division of education of the Panama Exposition an exhibit of interesting facts about text-book publication. They have recently issued the *New England Printer,* which is a facsimile reprint of this very unique and interesting little book. Teachers who may have the good fortune to attend the Panama Exposition this summer will be able to make use of this firm's employes who will be in attendance at their display. They will be only too glad to give information on almost every question which may arise concerning the Exposition.

ARTICLES IN CURRENT PERIODICALS.

American Botanist for February; *Joliet, Ill.; $1.00 per year, 25 cents a copy:* "An Illinois School Campus," Frank K. Balthis; "The Winter Flora of a Mountain Top," Walter H. Buswell; "A Garden of Associations," Charles F. Saunders.

American Mathematical Monthly for February; *5548 Kenwood Ave., Chicago; $2.00 per year:* "The History of Zeno's Arguments on Motion," Florian Cajori; "Groups of Subtraction and Division with Respect to a Modulus," G. A. Miller.

American Naturalist for March; *Garrison, N. Y; $4.00 per year, 40 cents a copy:* "Mutation en Masse," Harley H. Bartlett; "The Albino Series of Allelomorphs in Guinea-pigs," Sewall Wright; "Progressive Evolution and the Origin of Species," Arthur Dendy; Shorter Articles and Discussion—"The Origin of a New Eye-Color in Drosophila repleta and its Behavior in Heredity," Roscoe R. Hyde; "A Wing Mutation in a New Species of Drosophila," Roscoe R. Hyde; "Mutations in Two Species of Drosophila," C. W. Metz and B. S. Metz; "A Sex-linked Character in Drosophila repleta," Dr. A. H. Sturtevant.

Journal of Home Economics for March; *Roland Park Branch, Baltimore, Md.; $2.00 per year, 50 cents a copy:* "Waste," Mary U. Watson; "Dormitory Supervision," Elizabeth Goodrich; "Feeding School Children," Edward Brown; "A Sanitary Food Code," C. F. Langworthy; "Buying, Storing and Handling Food Supplies," Annie Dewey.

L'Enseignement Mathématique for January; *Stechert & Co., West 25th St., New York; 15 francs per year, 2 francs a copy:* "La périodicité du hasard," L. Bachelier; "Couple gyroscopique," F. Bouny; "Courbes et fonctions panalgébriques interscendantes," E. Turrière; "Sur l'emploi de certaines matrices de formes dans la résolution de problèmes de géométrie," L. Godeaux; "Le problème de l'interpolation et la formule de Taylor," R. Suppantschitsch; "Sur le trinôme du second degré," P. Suchar.

Nature-Study Review for March; *Ithaca, N. Y.; $1.00 per year, 15 cents a copy:* "Aims, Methods and Course of Study in Nature-Study in the Elementary School of the Mankato, Minnesota, State Normal School," Gilbert H. Trafton and Helen M. Reynolds.

Physical Review for February; *Ithaca, N. Y.; $6.00 per year, 60 cents a copy:* "A Determination of Latitude, Azimuth, and the Length of the Day Independent of Astronomical Observations," Arthur H. Compton; "Application of a Theory of Ionization by Impact to the Experiments of Franck and Hertz," Bergen Davis; "A New Form of Resistance Thermometer," S. Leroy Brown; "The Diurnal Variation of the Earth's Penetrating Radiation at Manila, Philippine Islands," Leopold J. Lassalle; "An Addition to a Theory of Ionization by Impact," H. W. Farwell; Atomic Numbers and Atomic Charges," Fernando Sanford; "Temperature Changes Accompanying the Adiabatic Compression of Steel," K. T. Compton and D. B. Webster; "The Electrical, the Photo-Electrical and the Electro-Mechanical Properties of Certain Crystals of Metallic Selenium, with Certain Applications to Crystal Structure," F. C. Brown.

Popular Astronomy for April; *Northfield, Minn.; $3.50 per year, 35 cents a copy:* "Korea's Cherished Astronomical Chart," W. Carl Rufus; "A Determination of Latitude, Azimuth and the Length of the Day, Independent of Astronomical Observations" (with Plates XI and XII), Arthur H. Compton; "Second Annual Report of the Section for the Study of the Aurorae, the Zodiacal Light and Gegenschein" (with Plates XIII and XIV), A. P. C. Craig; "An Endowed Astronomical Lectureship," Frederick Campbell; "Report on Mars" No. 8 (with Plates XV, XVI, XVII and XVIII), William H. Pickering; "Astronomical Teaching in the City" (Continued), Mary E. Byrd.

School Review for March; *University of Chicago Press; $1.50 per year, 20 cents a copy:* "Vocational Training in Chicago Schools," John T. McManis; "A Test of the Attainment of First-Year High-School Students in Algebra," Walter S. Monroe; "The Dictating Machine in the Schools," Howard F. Taylor; "Vocational Information for Pupils in a Small City

High School," W. A. Wheatley; "Some Facts About the General Science Situation," W. L. Eikenberry.

School World for March; *Macmillan Company, London, England; 7s. 6d. per year, 6 pence a copy:* "The Teaching of Mathematics in Girls' Secondary Schools," M. J. Parker; "Continuation Schools and the Training of Engineers," W. J. Deeley; "Experimental Agriculture in Rural Secondary Schools," T. F. Teversham.

Unterrichtsblätter für Mathematik und Naturwissenschaften, Nr. 1; Otto Salle, Elssholzerstr. 15, Berlin W. 57, Germany: M. 4 per year, 60 Pf. a copy: "Das Rationale in der algebraischen Geometrie," Prof. Dr. E. Haentzschel; "Beiträge zur numerischen Auflösung algebraischer Gleichungen mit Hilfe der Wurzelpotenzen," Schulrat Dr. Alois Lanner; "Die natürliche Deutung und Begründung des Eulerschen Polyedersatzes," Von denselben; "Der Kreis als Hilfskurve beim Beweise grundlegender geometrischer Gesetze," Bergschullehrer Dipl.-Ing. Carl Herbst; "Winkelsumme beliebiger *n*-Ecke," Von denselben; "Raumschach," Dr. F. Maack.

Zeitschrift für Mathematischen und Naturwissenschaftlichen Unterricht Aller Schulgattungen for February; *B. G. Teubner, Leipsic, Germany; 12 numbers, M. 12 per year:* "Zum Jubiläum der Logarithmen," Geh. Reg.-Rat. Prof. Dr. A. Gutzmer; "Ueber das geometrische Deuken mit besonderer Berücksichtigung der darstellenden Geometrie," Prof. Dr. C. Beyel; "Eine Konstruktion des Bildpunktes für Spiegel und Linsen," Oberlehrer Dr. E. Magin; Die neue Bayerische Schulordnung für die höheren Lehranstalten," Dr. W. Lietzmann.

TREE PLANTING.

Anyone who has at heart the conservation of our country's resources, cannot help but be in sympathy with the enactment of state and national laws which will compel every person who destroys a healthy tree, to be obliged to plant in its place at least three. Teachers who have the instruction of children of grammar and high school age in science, ought to bring home forcibly to their pupils the importance of tree planting. If the children can be brought to see the great value of trees in both city and country, they will, when they get out into the world, exert their influence in seeing that the reckless destruction of trees is curbed to a great extent.

THE TEACHER'S TRADE JOURNAL.

It is surprising what a number of teachers there are in the United States who do not have upon their subscription list a school journal of some kind. Many of these teachers seem to think that there is nothing in these periodicals that they do not already know, and that they are simply printing old, wornout material that they have read and heard about for years and years. These teachers are making a serious mistake in entertaining ideas of this nature, as there are many well edited, well managed educational journals published in the country, which are printing in each of their issues live, up-to-date matter which is the result of thoughtful investigation, experience, and trial on the part of progressive teachers. All teachers should become subscribers to at least two educational journals. These magazines may be to them trade journals in the same sense that "The Iron Age" is the trade journal of every hardware man in the country. Teachers need to know what other teachers are doing, and if they are unable to attend teachers' conventions for any reason, they will be able to secure practically the same knowledge through the medium of these high-class educational journals. It is hoped that those teachers who read this paragraph will take it in the spirit in which it is written and profit thereby. Will any who are already subscribers to several journals, do missionary work among your friends whom you know to be sadly deficient in progressive, instructive knowledge?

HIGH SCHOOL ATHLETICS.

The competitive athletics of our American colleges and universities often harbor unsuspected dangers in that they encourage overdoing on the part of the participants. No one would deny that systematic and even strenuous exercise may exert a most wholesome effect on the human organism. But the win-at-any-cost exertion, taxing vital organs to the very limit of their endurance, exceeding the factor of safety in physiologic functions, and sometimes carried to the breaking strain, represents a sort of unjustifiable self-sacrifice that may properly be made for one's country but is never called for to uphold the glory of one's college. The sooner it is realized that there are better tests of manliness than the ability to endure a 4-mile race in the college boat or to complete the football season in spite of acquired injuries, the more wholesome will American college life become.

Unfortunately, there is a widely manifested tendency for the pupil of the high school to ape the performances of his older brother in the college. This is shown in the introduction of Greek letter societies and social functions into the secondary schools, tending to counterbalance some of their wholesome features of social intercourse with the snobbery of exclusiveness and the deteriorating influence of late hours and tiring distractions. Even more baneful, however, is the growing custom of allowing the same sort of intense competitive sports in the high school that are the cause of complaint in respect to their dangers to the older college student.

We are glad to note, says *The Journal of the American Medical Association,* a spirit of protest in various parts of the United States against all the forces, social and athletic, which tend to deteriorate the American boy (or girl) at the adolescent age of the high school period. One health officer has recently made a public announcement that proper exercise in a well-equipped gymnasium, under the guidance of a trained instructor, is good for any one, but that competitive athletics, requiring most strenuous exertion, long and tedious training and self-denial, is positively bad for any one before full development, and that all such overacts tend to impair the keenness of the mind and interfere with school work proper, as well as to injure the body. The competitive interscholastic games which require great physical exertion and mental tension should be done away with and a good gymnasium, under the direction of one trained in physical culture, should be provided and work according to the condition and need of each pupil assigned. We agree, further, that mild and well-timed athletic exercise and occasional social functions will tend to relieve the monotony of school life and invigorate body and mind; but overindulgence is likely to be detrimental.

The dangers referred to are not insignificant; they are real. Prof. C. R. Bardeen of the University of Wisconsin has pointed out, in connection with the participation in athletics in his institution, that the increasing amount of heart disease noted in this country by life-insurance companies an dothers makes it important for the physician to make himself acquainted with the chief causes responsible for these conditions so that he can protect his patients. Over-exertion in competitive sports, especially in schoolboys, is one factor. From 5 to 10 per cent of freshmen entering the state university have enlarged hearts with dilatation attributable to athletic sports. This condition not only keeps these students out of college sports, but to some extent hampers their scholastic work in college.

Criticisms of this sort are never welcomed when they contravene established customs. Yet there is an obvious contradiction in directing the energies and funds of the state toward the prevention of disease and the establishment of habits of right living in the earliest years of our public schools, only to permit their undoing at a subsequent period.

OUTSIDE WORK FOR TEACHERS.

Many teachers are of the opinion that they have nothing to do toward improving the general social condition of the town in which they live otherwise than by exercising their influence in the class room, and in the school with which they are connected. A mistake is being made by those who believe this. The secondary school teacher especially, is eminently well equipped to be able to do outside work which will add tone to the general standing of the community in which the teacher lives. There are many side issues which can be indulged in. There are various forms of clubs which the teacher might promote, bringing to bear his knowledge of the particular subjects which he is teaching. Teachers really owe it to the community to get busy in some phase of social, charitable, or philanthropic work. Many will say that they have no time, but for the energetic, live, wide-awake instructor there will be plenty of time in which to devote some of his knowledge to the betterment of the community in which he is living.

NEW ENGLAND ASSOCIATION OF CHEMISTRY TEACHERS.

The fifty-second regular meeting of the New England Association of Chemistry Teachers was held February 27 at Roxbury Latin School, in Boston, President Wilhelm Segerblom, of Phillips Exeter Academy, presiding.

After the election of new members interesting reports were presented by the following committees: New Apparatus, Ralph W. Channell, South Boston High School, Chairman; Current Events, Ralph H. Houser, Noble and Greenough School, Boston, Chairman; New Books, Frederick C. Adams, Mechanic Arts High School, Boston, Chairman.

Mr. Clarence B. Hill, Chairman of the Industrial Committee, recommended the following excursions for members of the association: March 27, Watertown—Hood-Rubber Company, foundry of Walker and Pratt Co., Watertown Arsenal; April 17, Cambridge—Ward's Bakery, Carter Ink Co., Cambridge Pottery Works; May 1, Fitchburg—Trip in connection with the fifty-third regular meeting—Visits to various industries in the forenoon, meeting at the Fitchburg High School in the afternoon; May 22, Gloucester—American Fish Glue Co., Gloucester Fish Co., etc.

Professor Alexander Smith, Head of the Department of Chemistry in Columbia University, New York City, gave a very live address on, "Some Possible Items, New and Old, for the Course in Elementary Chemistry." Some of the topics which he discussed were: Action of Air in the Bunsen Burner Flame; The Shortest Route to Atomic Weights; The Cause of Valence, Electrons; The New View of a Crystalline Solid as Being Composed of Atoms and not Molecules; Physical and Chemical Change.

In discussing physical and chemical change Professor Smith gave some very pointed illustrations of the absurdity of many attempted distinctions between them, and showed the futility of trying to define chemical change at the beginning of a course in chemistry. During the address Professor Smith gave opportunity for questions and discussion, and many members made use of the opportunity.

The officers of the association for the current year are:

President—Wilhelm Segerblom, Phillips Exeter Academy, Exeter, N. H.
Vice President—N. Henry Black, Roxbury Latin School, Roxbury, Mass.
Secretary—John B. Merrill, High School, East Boston.
Treasurer—Alfred M. Butler, High School of Practical Arts, Boston.

JOHN B. MERRILL, *Secretary*.

A TEACHER'S CONCEPTION OF HER SUBJECT.

There is lurking in the minds of many instructors, the idea that a knowledge of their specialty is largely the only prerequisite for a successful career on the part of pupils in High School, and then too in life after the course has been finished. It seems to the writer that this is a very narrow view. The fact of the matter is, that there is no one particular subject which is more worth while for a pupil to pursue than another. The subjects that are laid down in the curricula of our High Schools are not to be studied for the subjects' sake, but they are to be studied under the direction of the proper teachers in such a way that they will assist in making men and women out of the pupils. The High School should not stand for scholarship alone, but for a high type of manhood and womanhood. We find that the successful teacher is the one who lays stress on this phase of secondary instruction. Get in close touch with your pupils by using tact and a large amount of common sense, and you will find that instruction in your particular branch will bemade much more easy, and at the same time you will be leanding your personality to the development of a high type of citizenship.

LABORATORY ASSISTANTS.

One place in which the effectiveness of the educational work in the larger high schools of our country can be greatly increased, is with the laboratory sciences. The situation now prevailing is that the instructors are obliged not only to handle the recitations, but they are at the same time compelled to do all the laboratory instructing which carries with it the getting out and setting up of apparatus, the keeping it in repair, returning it to its proper place after use, the review and marking of notebooks, and a host of minor matters which can be accomplished just as well and in many cases much better, by a graduate—say from that high school. This graduate could be employed at a salary of not more than one quarter that which is paid to the regular instructor. The saving thus of the teacher's time which could be diverted into more effective recitation work and more vigorous laboratory supervision, would count toward greater effectiveness of the high school in ways which can hardly be calculated as far as dollars and cents are concerned. Science instructors the country over, should work for this kind of laboratory assistance.

A REQUEST TO THE READERS OF THIS JOURNAL.

The readers of this Journal are numbered by the thousands, and its readers are unquestionably the most progressive of our science and mathematics teachers. There are many ingenious and inventive people among them. These instructors are from time to time devising new schemes for illustrating this point or that, or they are inventing new apparatus to carry out some old principle in a more simple way, or they are finding new schemes for conducting laboratory work both in and out of doors. In fact, new plans and methods are being evolved all over the country.

We are asking teachers who are doing this, to kindly put their ideas into writing and send to us for publication. A new scheme which is good for you is good for everyone else in the profession. Let us then have your ideas. This Journal is really the only medium that teachers of science and mathematics have in this country, for intercommunication. Make more use of it. Encourage the teachers in your school who are not subscribers, to get on its list. Remember that the Journal is founded for the distinct purpose of bettering the teaching of science and mathematics throughout the world.

A SUGGESTION FOR PHYSICS AND CHEMISTRY TEACHERS.

There is at present no unified system of dividing the time between the text and the laboratory in the two great subjects of physics and chemistry. Perhaps it is impossible to come to any definite result as far as uniformity is concerned, but it is suggested that if seven periods a week are devoted to either one of these subjects, the time might be profitably divided as follows:

One period, early in the week, may be given to a general illustrative lecture by the instructor, where experiments may be carried out which are altogether too complicated for the pupil, but where some of the great fundamental truths of these sciences may be brought out by the instructor himself. Then we might have two recitation periods per week, the first one being on the general subject matter in the text and a discussion of the points brought out in the preceding lecture. The second recitation may be largely given over to the discussion and solution of problems, as well as quizzes and an explanation of the laboratory work of the week preceding. The remaining four periods may be divided into two equal parts, so that the pupil may work in the laboratory two consecutive periods twice each week.

This plan, on the whole, will give very satisfactory results. Of course it goes without saying, that if there is more time at command, it may profitably be utilized between laboratory and recitation.

THE LACK OF HARMONY BETWEEN THE EDUCATIONAL AND THE BUSINESS END OF SOME CITY SCHOOLS.

It is an acknowledged fact that in some city schools the educational end is frequently hampered and is rendered much less efficient than it should be, through its inability to secure at the proper time the necessary material, such as laboratory supplies, crayon, lumber, coal, iron, etc. There should be no difficulty whatever on the part of any school in having the necessary supplies on hand when they are needed. The business administration should be brought to realize that the schools are not existing for its benefit, but that they exist for the education of the children and the betterment of the community. It will be found possible for the teaching force to do better work with the knowledge that they have all necessary supplies on hand, than they can possibly do when hampered from time to time by the non-arrival of the required material. The business department of our school systems is simply a means to an end, and is not the principal side of our educational system.

The principal of each school should be held responsible for the supplies that are furnished him, but at the same time he should have enough material so that the school may be unhampered in its work. In the case of laboratory sciences, each instructor should have apportioned to him a sum of money sufficient to meet the needs of the laboratory, he being privileged to spend the money where he can secure material and apparatus of the best quality for the least expenditure. Vouchers, of course, should be taken for each item, these being transmitted through the principal of the school to the general business management. In this way, laboratory work can be done very much more effectively, when the instructor knows that he has on hand a fund which he can use for emergencies. There is no question but what there are many supplies of one kind and another which may be needed during the year, but which the instructor cannot always foresee the need. Then there is the element of breakage, entirely an unaccountable condition, when the article broken must be replaced immediately in order to meet the demands of the laboratory.

There are many cities where it is absolutely impossible for the instructor to spend a cent of the city's money unless bids are first secured for the article needed. This takes time, and then is not productive of the best results. In most cases, the business management will insist on the purchase being made from the lowest bidder, who is very frequently an irresponsible firm whose goods are known to be of an inferior quality. If the matter were in the hands of the instructor, one could rest assured that he would get the best material for the least money.

Schools should insist that they be unhampered in any way by the non-furnishing of the necessities for the proper conduction of the school.

SCHOOL SURVEYS.

Nowadays when Boards of Education and Superintendents of Schools have nothing else to do they put under way a school survey in the system over which they have jurisdiction. This undoubtedly is a splendid scheme in order to discover just exactly where the schools are doing the most effective work, and at the same time discover where they are least efficient. If the survey is made according to the proper plans, and information secured from the most efficient sources, the survey may be productive of much good. It surely will be if the defects that may be discovered are remedied at once; likewise if encouragement is given to those phases of work that are producing the highest results. But in many cases these surveys prove useless from the fact that the persons engaged in making them, find, on entering certain class rooms the teacher knowing that she is under examination conditions, causes her to utterly fail to make good with her class at the time. But that same teacher, when she is alone with her class, may do the most effective work. This visitation of various class rooms is by no means the best method of determining the standard of a teacher's work. The result can in most cases be obtained from conversation with the principal and patrons of the school, and often from the pupils themselves. One phase of these surveys should be to investigate something about the internal coöperation of the teachers and principal with each other, in coördinating their work, not only in the class room but in the school as a whole, so that all interests centering in the institution may work in harmony to produce the highest efficiency.

VOCATIONAL TRAINING.

The Illinois State Teachers' Association has a very efficient committee at work on Vocational Education. They are making an extensive study of the situation, and are presenting the results of their labors in print, to the people of the state. The committee is especially interested in the work which the Chicago schools are doing in this phase of educational work. They have recently issued a little pamphlet on *Vocational Training in Chicago Schools,* which is very much worth the attention of all people interested.

The most important phase of vocational training in the state of Illinois at present, is the contest which is on between the unit and the dual system. From investigations made by this Journal, it seems that there is no substantial argument that can be presented for the dual system, when the cost and the general efficiency of the school system as a whole, is taken into consideration.

The idea of there being two Boards of Education and two Superintendents—indeed two separate school systems, one for the academic and

the other for the vocational side of education—would be just exactly as sensible as it would be to have two mayors and two councils in the great city of Chicago, one mayor and his council to be interested in the social and legal affairs of the city and the other mayor and council to be interested in the police and fire departments together with the engineering enterprises. One proposition is just as absurd as the other.

If there are people who advocate the dual system, why do they not go a step further and have three Boards of Education, one to preside over the entirely academic side, another to preside over the vocational side, and the third to govern a combination of the two? There are in Chicago many pupils who wish only the academic studies. There are others who are after the vocational training only; and there is the great third class which is demanding a part of each. How splendid it would be then if these three Boards of Education were put into operation! What a convenience it would be to the pupils! What an inspiration it would be to the taxpayers to have their taxes increased for the support of such a plan as this! Then, too, think how the athletics of these three distinct systems of schools would be enhanced! Think of the rivalry that would be engendered!

But the idea is absurd. Such a thing cannot exist. It must not exist. And what is absurd for three Boards of Education would be the same for two. What we need is a strong efficient Board of Education with the very best superintendent and assistants that can be secured.

The readers and patrons of this Journal ought to use their efforts and influence to see that the bill for Vocational Education on the unit system, which is now before the Legislature at Springfield, is enacted into a law, instead of some kind of a bill which, if put into effect, would not be productive of a high type of efficiency.

THE CHRISTMAS TREE FARCE.

One may be taken to task for attempting to do away with the old and religious custom which is so well established in this country—that of giving to our children during the holidays a Christmas tree to be loaded with their presents, knickknacks, candles, tinsel, etc. But it is time that a halt was called on this custom. Very few people realize the enormous number of trees that are annually destroyed by the working of this custom which exists wholly through sentiment. As nearly as the writer of this paragraph can determine, there are annually used in the United States somewhere near three million trees. When he says "used," he means cut. There were brought into the city of Chicago in December, 1914, approximately 400,000 Christmas trees. A very large percentage of these were never used for the purpose for which they were cut, and they were consequently destroyed. Anyone with a mathematical turn of mind can easily discover the acreage which these trees represent, supposing that they were planted ten feet apart each way. It means that an enormous acreage was destroyed with no practical or efficient return. It would seem that parents and instructors of youth should do something to discourage this foolish waste. And as for as the pleasure to be derived for our children is concerned, just as much could be got from a so-called "grab-bag" or basket, in which the presents might be placed, with strings leading from each gift to the outside, and with the people drawing out the presents in turn. We would find that exactly as much pleasure is derived from this sort of thing than by the use of the Christmas tree. Then, too, scores of fires which now annually occur at the Christmas celebration, would be entirely dispensed with. It is hoped that parents and teachers will take these remarks in the sense of assisting and helping in the conservation of our country's resources.

NOTE ON A PROBLEM IN ELIMINATION.

By PROF. W. W. BEMAN,
University of Michigan.

Two other solutions of problem in SCHOOL SCIENCE AND MATHEMATICS, March, 1915, p. 246.

I. Given $\dfrac{\cos(a-3x)}{\cos^3 x} = \dfrac{\sin(a-3x)}{\sin^3 x} = b,$ (1)

We can easily get $\sin(a-2x) = \frac{1}{2}b\sin 2x,$ (2)

and $\cos(a-2x) = b\cos 2x.$ (3)

$$\sin a = \tfrac{1}{4}b\sin 4x,$$

$$\cos a = \tfrac{1}{4}b(1+3\cos 4x),$$

$$\sin^2 4x + \cos^2 4x = 1,$$

gives the desired result.

II. From (2) and (3), expanding and eliminating, $\sin 2x$ and $\cos 2x$ we get,

$$\begin{Bmatrix} \sin a & -(\cos a + \frac{1}{2}b) \\ \cos a - b & \sin a \end{Bmatrix} = 0,$$

the result desired.

BOOKS RECEIVED.

Advance Theory of Electricity and Magnetism, by Wm. S. Franklin and Barry MacNutt, Lehigh University, Bethlehem, Pa. Pages vii+300. 15x22 cm. Cloth. 1915. $2.00 net. Macmillan Co., New York.

Elementary Electricity and Magnetism, by Wm. S. Franklin and Barry MacNutt, Lehigh University, Bethlehem, Pa. Pages viii+174. 12.5x19.5 cm. Cloth. 1914. $1.25 net. Macmillan Co., New York.

Vocational Mathematics, by Wm. H. Dooley, Technical High School, Fall River, Mass. Pages viii+341. 13x19 cm. Cloth. 1915. $1.00. D. C. Heath & Co., Chicago.

Theory of Measurements, a Manual for Physics Students, by James S. Stevens, University of Maine. Pages vii+81. 13.5x19 cm. Cloth. 1915. $1.25 net. D. Van Nostrand & Co., New York.

A Review of Algebra, by Romeyn H. Rivenberg, Peddie Institute, Heightstown, N. J. 80 pages. 13x19 cm. Cloth. 1914. American Book Co., Chicago.

Essentials of Biology, Geo. W. Hunter, DeWitt Clinton High School, New York City. 448 pages. 15x21 cm. Cloth. American Book Co., Chicago.

Plane Geometry, by J. H. Williams and K. P. Williams. 264 pages. 12.5x19 cm. Cloth. 1915. Lyons and Carnahan, Chicago.

Lesson in Appreciation, by Frank H. Hayward, Inspector of Schools, London County Council, England. Pages xi+234. 13x19 cm. Cloth. 1915. 75 cents net. Macmillan Co., New York.

Die Elektrische Kraftubertragung, Von Paul Kohn, Ingenieur. Pages 121, with 137 illustrations. 12.5x18.5 cm. Cloth. 1914. B. G. Teubner, Leipsic and Berlin.

Das Perpetuum Mobile, Von Dr. Frida Tchak. 103 pages, with 38 illustrations. 12.5x18.5 cm. Cloth. 1914. B. G. Teubner, Leipsic and Berlin.

Laboratory Exercises in the Principles of Agriculture, by Irwin H. Opt and Russell R. Spafford, University of Nebraska. 192 pages. 21.5x 24.5 cm. Paper. 1914. Wm. Welch Mfg. Co., Chicago.

A First Year of Science, by Dr. John C. Hessler, James Milliken University, Decatur, Ill. Pages xiii+484. 14x19.5 cm. Cloth. 1914. Benjamin H. Sanborn & Co., Chicago.

BOOK REVIEWS.

The First Year of Science, by John C. Hessler, Ph. D., James Millikin University. Pages xiv+484. 13.2x18.7 cm. Cloth. 1914. Benj. H. Sanborn and Co., Chicago.

This excellent text has been prepared with the idea that all pupils in the first year of high school should acquire knowledge of fundamental scientific facts and principles. In developing the course, Doctor Hessler has based it upon the fundamental ideas of physics and chemistry.

To quote from the preface, "It is hard to see how physiography, physiology, and biology, the usual subjects of the early high school years, can be taught satisfactorily unless the pupil has previously acquired the elementary physical and chemical conceptions which underlie these subjects." In characterizing the book, the author states that, "it is intended to stimulate *uncommon thinking about common things,* to produce a scientific attitude toward everyday problems, and to give scientific knowledge to as large a body of our people as possible."

The course consists of three parts: the text proper, the laboratory manual and the Teachers' Handbook. The first two may be had either bound together or in separate volumes.

The text proper consists of twenty chapters. Practically the first half of these is elementary physics and chemistry. The chapters on physics contain no formulas and only a few simple calculations, and there are no symbols or equations in the chapters on chemistry. "The author's plan is to give only the primary notions of *matter, force* and *chemical action.* These are needed by everyone; for general knowledge of common things as well as for later study in pure and applied science."

The latter half of the text contains chapters upon "Water, Heat, Air, and Light in the Home," "The Weather," "Rocks and Soil," "Plants," "Animals" and four chapters devoted to physiology and sanitation. These last contain material needed by schools giving a short course in physiology at the end of the year. Each chapter closes with a well arranged *summary* of topics, while a series of stimulating *exercises* are placed at the end of each section of the book.

The 311 *illustrations* add materially to the teaching power of the text. To this end descriptive matter has been added to them and they have been made as simple as possible.

A feature of the *laboratory exercises* is that they can be performed with simple apparatus, *alternative exercises* being also provided which may be performed at home. "Only by linking our science with everyday things can we hope to convince the pupil that science is only common sense applied to daily life."

The *handbook* on the *Teaching of First-Year Science* "is designed to assist the teacher in every possible way in making the elementary science course profitable and stimulating."

It is impossible in a review to give adequate expression to the many excellent features of this text. It is teachable, well printed, on good paper and gives evidence of unusual care and thought in its preparation. It is just such a book as the reviewer would have been very glad to read when as a boy he began to seek explanations for the common things about him.

It is to be hoped that a course similar to this may soon be required of each pupil in every high school. W. E. T.

Laboratory Furniture for Educational Institutions, from the Kewaunee Mfg. Co., Kewaunee, Wis. 262 pages. 15x22 cm. Cloth. 1914.

This is one of the finest apparatus catalogues which has come to our desk in a good many months. It is a book descriptive of laboratory furniture in the nature of tables, cabinets, desks, chairs, etc., made by a firm whose name is synonymous with honesty, integrity and good work. A copy of this catalogue should be in the hands of every laboratory science teacher, superintendent and Board of Education. Equipments purchased from this firm will prove satisfactory in every particular. The book is made up, first, of a list of hundreds of towns and schools where this equipment is used. In the book there are several plans of modern, up-to-date college and high school laboratories. There are 678 cuts of apparatus, etc., manufactured by the firm. These cuts are all half-tones. Description and dimensions are given under practically every cut. The book is printed on highly calendered paper, thus assuring splnedid prints. There is appended a collection of testimonials from schools in which the apparatus is used. This is a thoroughly progressive, up-to-date catalogue in every respect. Send for a copy.

C. H. S.

Household Science and Arts, by Josephine Morris, Boston Public Schools. 248 pages. 13x19 cm. Cloth. 1913. American Book Co., Chicago.

This is one of the most practical texts on this subject that has come to our desk in many a day. It is written in simple language and in such a way that the pupil will understand what is being said. It may not only be used in the class room, but housekeepers would do well to use it in their own homes. There are many helpful suggestions to teachers, as to how they may conduct their particular line of work. The central core of the book is for the teacher to persist in an ideal for each of her pupils. The various phases of good housekeeping are interestingly discussed. .There is no space here to mention them, but minute directions are given for the care of the coal range the oil stove, the table, etc. The book abounds with recipes of all kinds—in fact, it would be a serviceable cook book for any housekeeper. It is a splendid book to put into the hands of pupils. There are about 350 recipes for cooking foods. There is a general index of eight pages. The text represents the highest art in book making, and no household arts teacher will make a mistake if she selects this book as a basis for her work.

C. H. S.

Elementary Electricity and Magnetism, by Wm. S. Franklin and Barry MacNutt, Lehigh University, Bethlehem, Pa. Pages viii+174. 12.5x 19.5 cm. Cloth. 1914. $1.25 net. Macmillan Co., New York.

This is another of those interesting and helpful books gotten out by these authors. It is of such a nature that it might well be used in high school physics when the study of electricity and magnetism is taken up. It is written in a clear, understandable way, and profusely illustrated with 152 splendid drawings. These drawings are made to illustrate, and are evidently made purposely for this book. The major paragraphs begin in bold-faced type. There are five chapters, as follows: Effects of Electric Current; Chemical Effect of Electric Current; Heating Effect of Electric Current; Induced Electro-Motive Force; Electric Charge and the Conductor. This book should be owned by every person attempting to teach physics. It is up to date in every respect, and deserves a large sale.

C. H. S.

The High School, Its Function, Organization and Administration, by John E. Stout, Cornell College, Iowa. Pages xxiii+322. 14x19 cm. Cloth. 1914. $1.50. D. C. Heath & Co., Boston.

The author of this book has shown remarkable cleverness in presenting the American High School to the public, from many points of view. He has discussed the subject according to the recent changes in the social and educational conditions in the country. He has opened up fields of thought, and has presented new schemes for the proper governing and management of the High School which cannot but meet with the approbation of all intelligent readers and people who have been trying to get in touch with the secondary school system of the United States. The author discusses both the academic and vocational sides of the question and emphasizes the fact that the High School is the people's college and the place where the key to the highest possible efficiency in our country is to be found. Notwithstanding the fact that in some localities the High School is criticized, it is true that the influence which it wields with its young life is making itself felt in every corner of the nation.

The author devotes considerable space to the discussion of the curriculum, taking up in more or less detail the various studies. The book is one which all High School teachers should possess and read and study. It is one of the best books on the subject, printed. There are 23 chapters, and in the contents a synopsis of each chapter is printed. On the outside margin of each page is given in bold-faced type, at the beginning of each major paragraph, the key to the discussion in that particular paragraph. There is an index of four pages. The volume is printed on uncalendered paper, in large clear type, and is written in an interesting and attractive manner, and is a book which deserves and doubtless will have a wide and extensive circulation.

C. H. S.

Biology, by Gary N. Calkins, Columbia University. Pages viii+241. 14.5x 21.5 cm. 1914, Henry Holt & Co., New York.

A course in general biology for college purposes. It is said in the preface to be "based upon the excellent course outlined in Sedgwick and Wilson's General Biology," and offered only an account of the need felt "of a work along similar lines to cover a course of about thirty class exercises and as many laboratory periods." The book is, however, distinctly different from Sedgwick and Wilson.

The method of type study is followed, but the types are not so few in number as is often the case, and all of them are closely associated with discussions of biological principles. The principal types are Yeast, Amoeba, Chilomonas, Paramecium, Hydra, Pleurococcus and Sphaerella, Pteris, Lumbricus, Homarus, Taenia.

It will be noted that the plant types used are very few. These are introduced not for the purpose of acquainting the student with the problem of plant biology, but only to contribute to a better understanding of animal biology. The two chapters into which plants enter prominently occupy but 29 pages. In one of them yeasts and bacteria are used to develop ideas about cells; in the other, plants are discussed as the ultimate source of food for animals. The book is therefore a text of animal biology rather than one on general biology. As a presentation of the principles of animal biology it is a welcome work, and entirely worthy of the reputation and attainments of its author. W. L. E.

A Foundation Study in the Pedagogy of Arithmetic, by H. B. Howell, Ph. D., Principal of Public School No. 27, Jersey City, N. J. Pages xi+ 328. 14x20 cm. Price $1.25. 1914. The Macmillan Company, New York.

Part I includes a review of representative studies. 1. Genetic Studies; (a) Primitive Man, (b) Children, (c) Prodigies, (d) Number Forms. 2. Psychological Studies; (a) Perception, (b) Counting, (c) Fundamental Processes, (d) Reasoning. 3. Statistical Studies; (a) Efficiency, (b) Ideation, (c) Transfer, (d) Hygiene. 4. Didactical Studies of Apprehension. The discussion of these topics, replete with references to various books and authorities, is very illuminating. Part II gives an account of the author's experiments in studying the arithmetical abilities of certain school children, and the problem of the school child's concepts of number. H. E. C.

The Thirteenth Yearbook of the National Society for the Study of Education. Pages 124. 15x23 cm. Paper. Price 75 cents and postage. 1914. The University of Chicago Press, Chicago.

Three interesting papers on aspects of high-school instruction and administration make up this volume. I. Reconstructed Mathematics in the High School: The Adaptation of Instruction to the Needs, Interests and Capacities of Students. H. C. Morrison, Supt. of Public Instruction for New Hampshire. This discussion is in such close relation to fundamental principles that it should be of interest to teachers of all subjects. II. Supervised Study as a Means of Providing Supplementary Individual Instruction. E. R. Breslich, Department of Mathematics, University High School, University of Chicago. This paper presents the fundamental principles at the basis of the movement for supervised study, and a review of the experiments made in various parts of the country. III. North Central High Schools. W. A. Jessup, Professor of Education, University of Iowa, and L. D. Coffman, Professor of Education, University of Illinois. This paper is a study of the existing conditions in high schools. H. E. C.